Asset Impairment Model, Monitoring, and Investment Decisions: Evidence from Regression Kink Design

Seong Jin Ahn
School of Management Engineering
Korea Advanced Institute of Science and Technology
seongjinahn@kaist.ac.kr

Yupeng Lin
NUS Business School
National University of Singapore
bizliny@nus.edu.sg

Hojun Seo
Krannert School of Management
Purdue University
seo92@purdue.edu

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ABSTRACT

We examine whether the application of the asset impairment model spurs monitoring activities and investment decisions for long-term growth. For identification, we use the regression kink design (RKD) and focus on a narrow window around a point at which a firm's book-to-market ratio of assets (BTM) equals 1. We first show that the sensitivity of asset impairments to the BTM ratio substantially increases when the BTM ratio exceeds 1, identifying the kink point where the application of the asset impairment model is triggered. We then test whether monitoring and investment activities change around the kink point. We find an increase in shareholder voting against management and an increased likelihood of forced CEO turnover around the kink point. We also find increased R&D investments but decreased over-investments in capital expenditures and acquisitions around the kink point. Further analyses reveal that patent filings and patent values increase at the kink point.

Keywords: Asset impairment accounting; Regression kink design, Monitoring; R&D; Investment decisions

JEL classifications: M41, M42, G34, O31, O32

1. Introduction

Accounting rules for asset impairments deal with the fundamental measurement issue of investments, and the Financial Accounting Standard Board (FASB) and International Accounting Standard Board (IASB) recently re-visited this issue to understand the costs and benefits of the current asset impairment model vis-a-vis those of the amortization model (FASB 2019, IASB 2020).[1] The key distinction between the two models is that the impairment model requires firms to perform a costly impairment test assessing the likelihood and the amount of asset impairments while the amortization model does not require any tests. Thus, the focal point of the debate is whether the information generated from the asset impairment test yields sufficient efficiency gains. Prior studies have sought to understand the costs of the asset impairment model such as greater room for managerial discretion in its application. However, little attention has been paid to the model's benefits. Our goal is to fill this gap by examining whether the asset impairment model gives rise to economic benefits in monitoring and investment activities.

Due to the separation of ownership and control, the self-serving manager maximizes her private benefits of control rather than firm value, leading to lower managerial efforts, under-investment in productive projects for long-term growth, and over-investment in self-serving projects (e.g., Jensen 1986; Moeller et al. 2005; Décaire and Sosyura 2020). However, the principals are informationally disadvantaged because managers lack incentives to voluntarily share private information due to agency frictions and career concerns, especially when firm performance deteriorates (e.g., Berger and Hann 2007; Kothari et al. 2009; Armstrong et al. 2010). To discipline managers, theory predicts that the principal conducts costly contingent information collection: the

[1] https://asc.fasb.org/imageRoot/43/120453843.pdf, https://www.ifrs.org/projects/work-plan/goodwill-and-impairment/comment-letters-projects/dp-goodwill-and-impairment/#consultation

principal verifies the true state of nature when the managers' performance signal is sufficiently negative and falling below a predetermined theoretical threshold (Townsend 1979; Baiman and Demski 1980; Dye 1986; Armstrong et al. 2010). This gives rise to the demand for an efficient accounting system.

We argue that the asset impairment model is designed as a part of the accounting system to fulfill the objective of verifying the state of nature and thus enhancing the principals' information set. When the assets-in-place are expected to generate insufficient future cash flows to recover the book value of the assets, the asset impairment model requires firms to estimate the intrinsic values of the assets and determine the likelihood, timing, and amount of the asset impairment recognition. This measurement process leads managers, auditors, and corporate boards to investigate the underlying causes of the potential asset impairments, including agency problems and inefficiencies in past investment decisions (Shepardson 2019; Stein 2019). Also, the intrinsic values of assets are a function of management's future strategic plans and actions, including managers' conceptualization and implementation of strategies (Ramanna and Watts 2012). Hence, when triggered, the asset impairment test generates significantly detailed information, improving the principals' information set. This enables principals to make probabilistic inferences and update prior beliefs and thus increase the effectiveness of managerial monitoring (Baiman and Demski 1980; Earl and Hopwood 1981; Dye 1986; Armstrong et al. 2010; FASB 2001, 2019; Georgiadis and Szentes 2020), and discipline managers toward better strategic decisions (Cyert and March 1963; Levinthal and March 1981; Koberg 1987; Holmstrom 2005; Armstrong et al. 2010).[2] As such, the improved monitoring and guidance in turn lead managers to take the appropriate actions and adjust their subsequent investment behavior (e.g., Dittmar and Mahrt-Smith 2007; Becht et al.

[2] Whether impairment tests generate useful information and its implications for principals have long been emphasized by practitioners (https://home.kpmg/xx/en/home/insights/2020/03/goodwill-and-impairment-dp.html).

2016).[3]

While the theory is intuitive, to empirically test this prediction is challenging because the internal asset impairment process is unobservable. Prior studies examine the effects of realized asset impairment charges on external information environment and produce mixed evidence possibly due to managerial discretion and manipulations (Chen et al. 2008; Bens et al. 2011; Li et al. 2011; Darrough et al. 2014; Riedl 2004; Beatty and Weber 2006; Ramanna and Watts 2012; Li and Sloan 2017). The possibility of manipulations has an important implication for our research design: the actual recognition of asset impairments can be significantly delayed in the presence of manipulations, and thus the period when the asset impairments are recognized in financial statements does not coincide with the period in which the principals' information set regarding underlying causes of impairments is significantly improved.[4] As such, we cannot rely on ex-post incidences of asset impairment for identification. Also, drawing a causal inference is difficult because asset impairments are endogenously determined with a decrease in firm value (economic fundamentals), and changes in monitoring and investments (outcome variables).[5]

To address the identification challenge, we focus on an ex-ante determinant of asset impairments and examine a setting where the non-discretionary application of the asset impairment model is warranted. Specifically, we follow prior studies and use the book-to-market (BTM) ratio

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[3] Principals such as corporate boards can observe public signals such as stock returns and use that as a source of information for their monitoring and advising activities. However, the asset impairment test should help principals ascertain the detailed information underlying deteriorating firm performance such as the causes of poor performance, the effectiveness of prior actions, and existing agency frictions, which should be useful for monitoring and advising incremental to public signals (e.g., Armstrong et al. 2010). See Section 2.2 for detailed discussion.

[4] For example, Alciatore et al. (2000) find that a negative correlation between the impairment amounts and lagged returns is greater than the correlation with contemporaneous returns, indicating that asset impairments are not timely. See also Vyas (2011). Recent regulatory documents also address the consideration that asset impairment announcements are generally a lagging indicator of the external and internal economic factors that give rise to asset impairments. Public disclosure of asset impairments would provide users with confirmatory value rather than predictive value (FASB 2019).

[5] Furthermore, incidences of asset impairments can cause the supply-side effects of financing if the asset impairment disclosure affects a firm's reputation in capital markets. The supply-side effects would in turn affect the firm's investment behavior via the cost of capital, preventing us from drawing a clear inference.

of assets equal to 1 as a point where the application of the asset impairment model is triggered, and thus the likelihood of future asset impairments exhibits a structural increase (Ramanna and Watts 2012; Lawrence et al. 2013). The BTM ratio is a significant determinant of the asset impairments because the extent to which the book value does not recover the fair value of assets increases the likelihood of asset impairments (Beatty and Weber 2006; Frankel et al. 2008; Roychowdhury and Martin 2013). More importantly, Lawrence et al. (2013) rely on GAAP's authoritative guidance to model the non-discretionary application of the asset impairment model and articulate that the relationship between the BTM ratio and the future asset impairment significantly changes at the point of the BTM ratio equal to 1 due to the more stringent application of the asset impairment model (i.e., a kink; hereafter the *kink* point). They show that there exists a structural break in which the *sensitivity* of recognizing asset impairments to a firm's BTM ratio exhibits a sharp increase when the firm's BTM ratio exceeds 1. We exploit this unique feature and implement a nonparametric local polynomial regression kink design (RKD, hereafter).

The focus of RKD is to estimate a kink at a pre-determined point within a narrow window. The kink is estimated as a change in the *slope* of an outcome variable to the assignment variable, i.e., the BTM ratio, on the left-hand side of the kink point relative to that on the right-hand side. Since a firm's BTM ratio cannot be precisely manipulated by managers at the kink point, firms are thus randomly distributed in the narrow window (McCrary 2008; Calonico et al. 2014; see Section 4.2 for validity checks). Also, the BTM ratio equal to 1 is a point at which we do not expect sensitivities of other factors such as growth opportunities to the BTM ratio exhibiting similar structural breaks in the absence of the asset impairment model. Thus, an abrupt change in the sensitivity of monitoring or investment activities to the BTM ratio is plausibly attributed to the identifying variation of the application of the asset impairment model at the kink point (Calonico et al. 2014; Card et al. 2015).[6]

We first verify whether the BTM ratio equal to 1 is the kink point with respect to the application of the asset impairment model and thus generates the identifying variation. We find that both the sensitivities of the likelihood and the amount of future asset impairment losses to the BTM ratio exhibit a significant kink across the kink point within a narrow band.[7] We find that a 1 percent increase in the BTM ratio has a 0.85 percentage point greater effect on the likelihood of future asset impairments on the right side of the kink (i.e., BTM ratio above 1) than on its left side (i.e., BTM ratio below 1). These findings are consistent with prior studies and validate our identification strategy.

Next, we examine monitoring activities around the kink point. First, we investigate shareholder voting against management, which is one of the essential observable shareholder engagement measures (Iliev et al. 2015; McCahery et al. 2016).[8] Consistent with our expectations, we find that they exhibit a significantly positive kink at the kink point. Second, to complement the shareholder voting test, we examine forced CEO turnover decisions. Forced turnover is a critical board decision that has a large impact on shareholder value, and the threat of termination provides managers an incentive to take appropriate actions (Huson et al. 2001; Gibson 2003; Armstrong et al. 2010; Guo and Masulis 2015). Consistent with our expectations, we also find a significantly

[6] RKD estimation essentially enables us to recover the effects of an endogenous regressor (the asset impairment model) that is a function of an observable assignment variable (the BTM ratio) on the outcome variables (monitoring or investment activities). The RKD estimator recovers such effects from the ratio of the change in the slope of the outcome variable around the kink to the change in the slope of the asset impairment function (e.g., Kisin and Manela 2018). See Section 3 for more detailed discussion.

[7] We use optimal bandwidths in our tests (Calonico et al. 2014; Card et al. 2015). See Section 3 and Appendix B for details on the optimal bandwidth estimation.

[8] McCahery et al. (2016) document survey evidence that investors' private discussion with top management is the most important engagement measure, which is unobservable to researchers. The second important measure is shareholder voting against management; 53% of respondents report voting against management as an engagement channel. Prior research shows that proxy advisors such as ISS collect information to inform investors, and investors also collect decision-relevant information via communication with management and board members outside of management (e.g., Cai et al. 2009; Ertimur et al. 2013; McCahery et al. 2016).

positive kink in the forced CEO turnover likelihood at the kink point.

Then, we check investment activities around the kink point. Specifically, we explore whether the improved information set of the principals leads managers to invest more in productive projects for long-term growth, i.e., R&D investments (Hambrick and Schecter 1983; Quinn 1986; Karim 2009). We find that R&D investments show a significantly positive kink at the kink point. We also explore whether inefficient managerial investment behavior is changed. Prior research suggests that managers opt to over-invest due to agency problems (Jensen 1986; Holmstrom 1989; Harford 1999; Harford and Li 2007). Thus, we examine over-investment in capital expenditures and acquisitions (e.g., Biddle et al. 2009) and find a significantly negative kink at the kink point. To further corroborate the inference, we explore the patenting activities of the firm (Kogan et al. 2017) and find that the number of future patent filings and patent values exhibits a significantly positive kink around the kink point.

It is possible that the assignment variable (the BTM ratio of assets) may be correlated with other unobservable factors (e.g., a firm's growth opportunities, investor attention, or earnings management) rather than the application of the asset impairment model, and that these could also affect monitoring and investment activities. However, note that these alternative explanations should specify (1) the ex-ante theoretical supports for the relationship between the BTM ratio and those factors and (2) the abrupt changes in the *sensitivity* to the BTM ratio at the same kink point within a narrow window.[9] A critical feature of RKD is that a simple monotonic relation between the assignment variable and the potential confounding factors or a level change cannot drive the

[9] For instance, it is unclear why the extent to which the book value of assets-in-place does not recover the fair value of assets increases with growth opportunities and thus R&D investments, and if any, why this association significantly changes at the BTM ratio equal to 1. Note that the Q-theory predicts that firms with more growth opportunities will increase investments, i.e., a monotonic relation, and this prediction works against our prediction. Also, our argument and findings do not contradict prior studies addressing managerial discretion involved in the application of the asset impairment model as we focus on the ex-ante determinant of asset impairments rather than the ex-post incidence of asset impairments for our identification.

kink effects at exactly the same kink point (Calonico et al. 2014; Card et al. 2015).

To alleviate concerns about potential confounding factors, we conduct three additional tests. First, we find that the kink effects on monitoring and investment activities are absent in the pre-asset impairment accounting regime, indicating that the treatment effects are likely driven by the application of the asset impairment model. Second, we use the BTM ratio of *equity* in RKD estimation and find insignificant results. Even though the BTM ratio of equity can be correlated with the confounding factors similarly to the BTM ratio of assets, it is less likely to capture the structural changes in the intensity of the model's application in a narrow window as precisely as the BTM ratio of assets because the application relies on asset values rather than equity values.[10] Third, we find that discretionary accruals do not exhibit any significant kinks at the kink point, suggesting that earnings management does not play an important role in our setting.

We acknowledge that there is a limitation in our research design. We measure the BTM ratio of assets at the aggregate firm level, while the asset impairment model requires firms to compare the fair value of a reporting unit (or a specific asset) with its carrying value. Put differently, it is possible that a reporting unit's BTM, which is not observable by researchers, can be different from the firm's overall BTM. However, note that this possibility increases the Type II errors in our empirical tests, and therefore works against finding evidence consistent with our hypotheses. That is, to the extent that the aggregate BTM captures a structural break of the impairment model's application at the aggregate firm-level, RKD allows us to identify the plausible treatment effects of the assignment variable (e.g., see discussions in Keys et al. (2010) using an ad hoc threshold).

We contribute to the literature in the following ways. First, we extend the growing literature on the real effects of accounting. As noted in Roychowdhury et al. (2019), a fundamental question

[10] See footnote 9 of Lawrence et al. (2013) for detailed explanation.

in accounting is whether and to what extent financial reporting facilitates the allocation of capital to the right investment projects.[11] We focus on specific accounting rules that are most relevant to corporate investment activities and document that the application of the asset impairment model affects investment decisions. Providing such context-specific real effects of accounting rules can better help regulators grapple with specific reporting issues (Kanodia and Sapra 2016; FASB 2019).

Second, we contribute to the accounting literature on asset impairments. Regulators and practitioners have long discussed the costs and benefits of the asset impairment model vis-a-vis the amortization model (FASB 2001, 2019). The vast majority of prior studies generally conclude that the asset impairment model allows managers to exert significant discretion, leading to opportunistic accounting (Francis et al. 1996; Alciatore et al. 1998; Riedl 2004; Beatty and Weber 2006; Ramanna 2008; Ramanna and Watts 2012; Li and Sloan 2017). To our knowledge, however, prior studies do not consider the potential positive effects of the asset impairment model and its impact on corporate decisions. Our paper provides new insights into how asset impairment accounting enhances monitoring and changes investment decisions to add value to the firm.

2. Institutional background and testable predictions

2.1. Institutional background and prior literature

SFAS 142 and SFAS 144 regulate financial accounting for long-lived asset impairments. First, SFAS 142 provides detailed guidelines concerning the recognition of goodwill impairments. The goodwill impairment test is performed at least annually at the reporting unit level. For a given

[11] The extant studies extensively focus on generic accounting quality, such as accruals quality and accounting conservatism. Kausar et al. (2016) document that obtaining a financial statement audit reduces financing frictions, increasing corporate investments. Shroff (2017) documents that general U.S. GAAP changes have implications in corporate investments. Biddle et al. (2009) find that accounting transparency is associated with higher capital investment efficiency.

reporting unit, the test is a two-step procedure. The first step requires firms to assess the likelihood of asset impairments by evaluating a reporting unit's total fair value and comparing the fair value with its carrying amount, including goodwill. If the total fair value exceeds the total carrying amount, the goodwill assigned to the reporting unit is considered not impaired, and the second step of the impairment test is unnecessary. If the carrying amount exceeds the fair value, the second step measures the goodwill impairment losses as the difference between the reporting unit's total fair value and the sum of the fair values of the reporting unit's other non-goodwill net assets (SFAS 142 Paragraphs 19 & 20, 2001).

Second, SFAS 144 regulates the process of asset impairments.[12] If an entity experiences events or changes in circumstances that indicate a change in the carrying amount of an asset that the entity expects to hold, the entity shall estimate the future cash flows expected to result from the use of the asset. If the carrying amount of a long-lived asset (asset group) is expected to be not recoverable by the estimated future cash flows, an impairment loss shall be recognized. The asset impairment loss is measured as the amount by which the carrying amount of the asset exceeds the fair value of the asset (SFAS 144 Paragraphs 7-24, 2001).

Prior studies examine whether the asset impairment charges recognized in the financial statements are informative but produce mixed evidence. For example, the announcements of asset impairment charges are associated with negative stock returns (Bens et al. 2011; Chen et al. 2008; Li et al. 2011) and often are followed by downward revisions of analyst forecasts (Li et al., 2011). The negative market reaction suggests that impairment charges act as a morning call and induce investors to re-assess the managerial ability and firm fundamentals. Along the same line, Darrough et al. (2014) find that the recognition of goodwill impairment charges is associated with CEO pay

[12] SFAS 144 retains the requirements of SFAS 121 to recognize an impairment loss for long-lived assets.

decreases, suggesting that compensation committees hold CEOs accountable for non-value maximizing acquisitions. However, several papers question the informational value of the impairment charges by arguing that current impairment rules leave too much room for managers to delay or otherwise manipulate the impairment charges (e.g., Beatty and Weber 2006; Ramanna and Watts 2012; Li and Sloan 2017). Different from these studies, we examine the corporate governance role of the asset impairment accounting rules in shaping corporate investment decisions. Also, our paper takes a novel empirical identification approach and focuses on the ex-ante determinant of asset impairments rather than realized asset impairment charges to understand whether and how the asset impairment accounting rules give rise to economic benefits.

Prior research conceptualizes the idea that the sensitivity of asset impairment loss recognition to the BTM ratio of assets changes around the BTM ratio equal to 1. These studies use the BTM ratio as a key control variable when they examine goodwill or long-lived asset impairments loss recognition (Beatty and Weber 2006; Frankel et al. 2008; Roychowdhury and Martin 2013). The extent to which the book value of assets does not recover the market value of assets increases the likelihood of triggering the stringent asset impairment test. In this sense, Ramanna and Watts (2012) use a sample of firms whose BTM ratios are greater than 1 and examine the managers' goodwill impairment decisions. In particular, Lawrence et al. (2013) state "the beginning of period ratios reflects the likelihood that non-discretionary write-downs are warranted" and demonstrate the conceptual relationship between the asset impairments and the BTM ratio (see figures 1 and 2 therein). They describe this relationship as a piecewise linear relation: the sensitivity of asset impairments to the BTM ratio (i.e., the linear slope) abruptly increases when the BTM ratio exceeds 1.[13]

[13] Although Lawrence et al. (2013) and Ramanna and Watts (2012) use BTM ratio equal to 1 as the point at which asset impairment changes may occur, the precise definition varies. Lawrence et al. (2013) use BTM ratio of assets

As indicated by Lawrence et al. (2013), an identification strategy in our setting requires empirical measures of the book value and fair value of the firm's assets, which are not readily available to researchers. Therefore, to address this issue, we follow prior research and use the firm's aggregate book value and fair value of the assets.[14] The fair value of the assets is estimated using the sum of a firm's market value of equity and the book value of the liabilities. We then relate the total aggregate asset impairments with the aggregate BTM ratio of assets. We use total impairments rather than separating long-lived asset impairments from goodwill impairments. The impairments guided by SFAS 142 and 144 are likely linked to each other, and therefore a firm's decision to impair one class of assets is not independent of the impairment decision for another class of assets (e.g., FASB 2001; Riedl 2004; Stein 2019).[15] In Section 4, we perform validity checks and examine whether the aggregate asset impairments show a positive kink around the kink point of the firm-level BTM ratio of assets equal to 1.[16]

2.2. Testable predictions

If the market signals of the asset values indicate that the book values of the assets cannot be recovered, the current U.S. GAAP requires a re-estimation of future cash flows generated from past investments to determine the intrinsic values of the assets in the asset impairment test. We posit that this measurement process has direct implications for a firm's subsequent investments

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while Ramanna and Watts (2012) use BTM ratio of equity. In this paper, we follow Lawrence et al. (2013) in our main analysis and provide further analysis following Ramanna and Watts (2012) in Section 5.

[14] For this reason, although asset impairment rules are set by SFAS 142 and 144, it is possible that slippage exists between the theoretical value of impairment losses to be recorded by the accounting rule and the realized value in the data in practice (e.g., see Lawrence et al. 2013 for more detailed discussions). Thus, we acknowledge that there are at least two potentially unobserved factors: 1) the reporting unit and 2) the calculation of the market value of underlying assets by managers and auditors. Note that these factors and associated measurement errors work against finding a significant kink effect in the asset impairment function with respect to the BTM ratio.

[15] As aforementioned, the fair value of goodwill is defined as the difference between the reporting unit's total fair value (from step 1) and the sum of the fair values of the reporting unit's other non-goodwill net assets, indicating that goodwill and other assets are jointly evaluated in the goodwill impairment procedure.

[16] In untabulated results, we test impairments under SFAS 142 and impairments under SFAS 144 separately and find that a kink exists at BTM ratio equal to 1 for both.

and growth strategies. SFAS 142 and 144 provide detailed guidelines on when and how much to adjust the balances of previous investments. This periodic mandatory re-measurement process produces useful information that guides managers, corporate boards, and other stakeholders of the firm. We elaborate on this point below in the classic agent-principal framework.

Due to the separation of ownership and controls and delegated decision-making, a self-serving manager arguably prefers to invest in a self-serving project that yields a lower firm value for principals but generates higher private benefits to the manager (e.g., Jensen 1986; Chetty and Saez 2010). Given that information asymmetry exists and information acquisition is costly, principals cannot readily observe the nature of managerial investment decisions, the underlying economics of investments, and the private benefits that managers can extract. Accordingly, the degree of over-investment in self-serving projects and that of underinvestment in productive projects are at least in part determined by the intensity of principals' information acquisition and associated monitoring.

To discipline managers, therefore, prior research suggests that principals engage in costly contingent state verification and information acquisition. Specifically, relying on a principal-agent model, Dye (1986) shows that principals will conduct costly contingent information acquisition only when the signal about the agent's performance is sufficiently low and falls below a theoretical threshold. Following Dye (1986), we posit that the information acquisition and thus associated monitoring is contingent upon and thus specified by the level of the intrinsic value of assets. When the intrinsic value of assets is sufficiently high, the likelihood of asset impairment is remote, and minimal accounting actions and state verification concerning asset impairments are required by asset impairment accounting rules. Such a scenario is empirically manifested when BTM is far below 1. That is, when BTM is below 1, additional information would not be generated and the principal's information set is not altered. As such, the monitoring intensity in this regime is close to a reserved level in this case.

However, when the intrinsic value of assets-in-place is sufficiently low and expected not to be recovered (i.e., BTM>1), the application of the asset impairment model is triggered and the principal engages in costly information acquisition to understand the true state of nature and likely causes of asset impairments (e.g., Shepardson 2019; Stein 2019). Prior research suggests that the accounting system plays a crucial role in providing information about the agent's behavior and performance (Butterworth 1972; Baiman and Demski 1980; Earl and Hopwood 1981; Armstrong et al. 2010). In our research setting, we argue that costly asset impairment tests and the (internal) reporting process expand the principals' information set regarding inefficiencies in prior investments and existing agency problems. Also, this process enhances overall understanding and assessments of management's future actions and plans in combination with assets-in-place, including managers' conceptualization and implementation of firm strategies because it is critical to understand when and why those past investments are not expected to generate returns sufficient to recover the investment costs. This evaluation and re-measurement process updates the principals' information set and thus prior beliefs regarding the degree of agency problems, inefficiencies in past investments, and unrevealed managerial actions, which allows them to subsequently achieve more effective managerial monitoring.

Based on the above discussion, we posit that the detailed information generated from the asset impairment test is useful for principals incremental to public signals such as stock returns. This argument is also in line with prior research highlighting the role of detailed and disaggregated information in corporate governance mechanisms (Watts and Zimmerman 1986; Berger and Hann 2003; Armstrong et al. 2010). Grossman and Stiglitz (1980) show that stock markets cannot be informationally efficient. Armstrong et al. (2010) specifically point out that "*Although stock price performance and comparisons of stock price performance with competing firms may provide boards with valuable signals of whether the CEO has done a good or bad job over a period of time, stock price alone is unlikely to provide much information about what specific actions the CEO might have taken, or not taken, to achieve this performance.*" In this sense, the detailed information and knowledge underlying poor performance generated from the asset impairment test can aid principals in determining the quality of the managers and whether they are a good fit for the organization, and thus it is useful to correct agency problems and poor investments.[17]

We expect that when managers expect more stringent monitoring by principals, they would alter their subsequent investment behavior. Specifically, the enhanced monitoring would lead to a decrease in the net payoffs from undertaking self-serving projects relative to productive projects in subsequent investment decisions. Rational managers anticipate such a disciplining effect of monitoring and thus adjust their investment strategy accordingly to reallocate more resources from self-serving projects to productive projects. Note that this argument is in line with the large body of literature on managerial empire building, which emphasizes the role of enhanced corporate governance mechanisms effectively encouraging managers to undertake productive projects but curtailing self-serving projects (e.g., Lang et al. 1991; Kanniainen 2000; Dittmar and Mahrt-Smith 2007; Masulis et al. 2007).

In addition, the improved information set can enable the principals to discipline managers toward better strategic decisions (Cyert and March 1963; Levinthal and March 1981; Koberg 1987).

[17] Although Armstrong et al. (2010) discuss this role of disaggregated and detailed information in the context of financial reporting, this argument is equally applicable to our setting: the detailed information generated from the asset impairment test is useful incremental to public signals such as stock returns. In Appendix C, we check the robustness of our results by including current and past stock returns (Ramana and Watts 2009), which are the most notable and relevant signal, as an additional covariate in RKD estimation and find that our inferences are qualitatively similar.

Prior research shows that the availability of information plays a critical role in this process (Holmstrom 2005; Armstrong et al. 2010), and therefore the principals engage in a series of interactive actions such as information gathering to understand the effectiveness of prior actions and influence future managerial actions (Koberg 1987). However, managers who have informational advantages lack incentives to voluntarily share private information due to agency frictions and career concerns, especially when firm performance deteriorates (Berger and Hann 2007; Kothari et al. 2009; Armstrong et al. 2010). If the asset impairment test helps principals ascertain the detailed information underlying deteriorating firm performance, it should be helpful for them to better monitor and guide managers.

Overall, if the principals' improved information set stemming from the application of the asset impairment model drives changes in monitoring and investment activities, we expect to observe that the patterns of monitoring and investment activities around the kink point (i.e., BTM equal to 1) will follow the pattern of the model's application intensity. That is, given that there exist structural changes in the sensitivity of the asset impairments to the BTM ratio when the BTM ratio exceeds 1, we expect similar structural changes in the sensitivity of monitoring and investment activities to the BTM ratio at the same kink point. We proceed to discuss our identification strategy below.

3. Identification strategy: Regression Kink Design (RKD)

We exploit the kinked structure in the application of the asset impairment model and employ a nonparametric local polynomial RKD. In RKD, the slope of the likelihood of being treated changes at a kink point, resulting in a discontinuity in the *first derivative* of the assignment function. Prior studies show that RKD helps overcome endogeneity issues in the OLS framework when the regressor is an endogenous variable but an instrumental variable is hard to find (Calonico et al. 2014; Card et al. 2015). RKD is built on a nonparametric local polynomial identification framework, which allows non-separability of the error term and non-linear effects of assignment variables. A general single kink model is

$$Y = y(P, X, \varepsilon) \tag{1}$$

where Y is an outcome, P is a policy-related variable of interest, X is an observed covariate (i.e., assignment variable), and ε is a potentially multidimensional error term that enters the function y in a non-additive way. The policy-related variable P is determined by the observed assignment variable X, generating a kink function $P = p(X)$. Note that this kink function is predetermined by an exogenous policy. In our context, the outcome variable Y is monitoring- and investment-related variables. P is goodwill/long-lived asset impairment loss. X is the BTM ratio of assets.

There are two key assumptions in RKD. First, a kink in the function $p(X)$ around the kink point is the only source of discontinuity in the *slope* change of Y around the kink point.[18] That is, the response function Y is continuous and partially differentiable with respect to P and X, and both of these partial derivatives are continuous around the kink point. In our context, there exists a structural break in the sensitivity between asset impairments (policy variable) and the BTM ratio of assets (assignment variable) at the kink point at which the BTM ratio equals 1. Additionally, in a close neighborhood around the kink point, there are no kinks (i.e., sensitivity changes) in the *direct effect* of the BTM ratio and asset impairments on outcome variables.

Second, the assignment variable cannot be *precisely* manipulated. Note that the BTM ratios are significantly affected by the demand and supply of equity shares in competitive capital and

[18] The change in slope is interpreted as change in speed. In our setting, the increase of the slope at the cutoff, i.e., BTM equal to 1, represents the increase of the impairment speed for a unit change of the BTM ratio on the right of the cutoff compared with that on the left.

product markets. Hence, the market value of assets and the BTM ratios are unlikely to be precisely manipulated by managers. Therefore, by restricting samples to those lying within a narrow window around the kink point, the assignments of treatment samples (i.e., observations with the BTM ratio >1) and control samples (i.e., observations with the BTM ratio <1) can be viewed as reasonably random. We follow prior studies and use optimal bandwidths in all of our main tests (see Calonico et al. 2014 and Card et al. 2015 for detailed discussions).

Under these assumptions, the treatment effect using RKD can be described as:

$$T_{rk} = \lim_{h \to 0} \frac{dE[Y_{1i}|x < X_i < x + h] / dx}{dE[P|x < X_i < x + h] / dx} - \lim_{h \to 0} \frac{dE[Y_{0i}|x - h < X_i < x] / dx}{dE[P|x - h < X_i < x] / dx} \quad (2)$$

where i stands for units, Y_{1i} is the outcome when i is in the treated group, Y_{0i} is the outcome when i is in the control group, x is the kink point, and h is the narrow window around the kink point. The equation also defines the narrow window of h left of x and the narrow window of h right of x , i.e., $x - h < X_i < x$, $x < X_i < x + h$. In our setting, the treatment effect is identified when the kink in the relationship between the BTM ratio and the outcome variable (monitoring and investment) coincides with the kink in the asset impairment function.

To estimate equation (2), Calonico et al. (2014) and Card et al. (2015) suggest the following local polynomial regression model:

$$\hat{T}_{rk} = \left(\hat{\beta}_1^+ - \hat{\beta}_1^-\right) / (\hat{R}_1^+ - \hat{R}_1^-) \quad (3)$$

where $\hat{\beta}_1^+ - \hat{\beta}_1^-$ is the difference in the slope estimated from the right side of a narrow window around the kink point ($\hat{\beta}_1^+$) and the slope estimated from the left side of a narrow window around the kink point ($\hat{\beta}_1^-$) in the relationship between an outcome variable (i.e., monitoring or investments in our setting) and the BTM ratio. $\hat{R}_1^+ - \hat{R}_1^-$ is the difference between the slope estimated from the right side of a narrow window around the kink point ($\hat{R}_1^+$) and the slope estimated from the left side of a narrow window around the kink point ($\hat{R}_1^-$) between the likelihood (or the amount) of asset impairments and the BTM ratio, which is generated by the application of the asset impairment model.[19] Appendix B provides detailed explanations of the treatment effects using local polynomial regression.[20]

4. Empirical Results

4.1. Data and sample

We use the Compustat database to obtain annual accounting data. Our sample period is from 2002 to 2015.[21] We follow Lawrence et al. (2013) to construct variables and require non-missing observations of total assets, the book value of equity, the number of shares outstanding, and the share price. We also require non-missing observations of the outcome variables in each test. We obtain the shareholder voting data from the ISS Voting Analytics database. Forced CEO turnover data are hand-collected based on the algorithm described in Parrino (1997) and Peters and Wagner (2014). We obtain data on patent filing and the patent value from Kogan et al. (2017).[22] To mitigate the influence of extreme observations, we winsorize continuous variables at 1% and 99%.

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[19] Drawing a parallel to two-stage least squares (2SLS) for intuition, 2SLS recovers the effect of an endogenous variable on an outcome variable by the ratio of the reduced-form effects (i.e., the effect of IV on the outcome variable) to the first-stage effects (i.e., the effect of IV on the endogenous variable) (Wooldridge 2010). In the RKD estimation, if a large slope decrease in the outcome variable with respect to the BTM ratio (the "reduced-form") coincides with a modest slope decrease in the future asset impairments with respect to the BTM ratio (the "first-stage") at the same kink point, then the future asset impairments have a large positive effect on the outcome variable, and its economic magnitude can be measured by the ratio of the reduced-form effect to the first-stage effect (Card et al. 2015; Kisin and Manela 2018). As such, the kink in the observed outcome variable as a function of the BTM ratio arises due to the kink in the asset impairment function.

[20] Note that $\hat{\beta}_1^-$ absorbs any smooth effect of the BTM ratio on the outcome variables (i.e., monitoring and investment activities).

[21] Both SFAS 142 and SFAS 144 were revised in 2001. There were no updates to regulations related to long-lived asset impairment, but substantial revision for goodwill impairment occurred in 2001. We terminated our sample in 2015 because the forced CEO turnover data is available up to 2016. Note that all outcome variables are measured in *t*+1 and BTM ratio is measured in *t*.

[22] https://github.com/KPSS2017/Technological-Innovation-Resource-Allocation-and-Growth-Extended-Data

Table 2 provides descriptive statistics. Following Lawrence et al. (2013), BTM_t is the BTM ratio of the assets at the end of period *t* and is defined as the book value of total assets divided by the market value of assets at the end of period *t*. The market value of assets is measured as the market value of equity plus the book value of total liabilities. In our sample, the mean value of the BTM ratio is 0.714, which is similar to that in Lawrence et al. (2013). We find that approximately 16.8% of firm-year observations in our sample report asset impairments. The average amount of asset impairment is 1.5% of the market value of equity. Note that for different specifications, the optimal bandwidth can vary due to the different data structures of outcome variables. Therefore, in our empirical tests, different tables could cover different numbers of observations lying in a different optimal bandwidth.

4.2. Empirical results

4.2.1. Validating assumptions in RKD - Density test

A critical identifying assumption for a valid inference in RKD estimation is that the assignment variable (i.e., the BTM ratio of assets) cannot be precisely manipulated. Note that the market value of assets is mostly determined by the time-varying demand and supply of the equity and debts, which is unlikely to be precisely manipulated. Nevertheless, we employ a density test to validate this assumption (McCrary 2008; Cattaneo et al. 2018). Specifically, we examine whether the density of the assignment variable is smooth at the kink point. In other words, if managers can manipulate the BTM ratio, then we should observe a discontinuity in density at the kink point (e.g., Burgstahler and Dichev 1997), suggesting that the BTM ratio is no longer comparable between the right- and left-hand sides of the kink point.

In Table 1, we examine whether the density of the BTM ratio evolves smoothly, supporting an absence of precise manipulation when observations are lying within a narrow band around the cutoff. Specifically, we test discontinuity in density at the kink point (i.e., manipulation testing) using a local polynomial density estimator and an optimal bandwidth. Consistent with our expectations, the results confirm that the smooth density assumption is valid. Using the local 1-order polynomial model (2-order polynomial model), we do not find significant discontinuity on density around the kink point with a *p*-value of 0.116 (0.603). Figure 1 illustrates the smooth density around the kink point where the BTM ratio equals 1 and demonstrates that the distribution of our sample evolves smoothly around the kink point.

4.2.2. Kink effects in the application of the asset impairment model

We first estimate the kink effects of the BTM ratio on the future asset impairments, which are generated by the application of the asset impairment model (i.e., the kink function $P = p(X)$ in equation (1)). Specifically, we examine whether the sensitivity of the likelihood and the recognized amount of future asset impairment losses to the BTM ratio of assets are significantly different on the left- and right-hand sides of the kink point.

Figure 2 provides a graphical illustration of how the sensitivity of asset impairments to the BTM ratio evolves around the cutoff point where the BTM ratio equals 1. In Panel A, the Y-axis is the indicator of impairment loss recognition in period t+1, and the X-axis is the BTM ratio at the end of period t. The solid line represents the estimated slope that is plotted using the data within the optimal bandwidth.[23] Observations are restricted to those lying within the optimal bandwidth. We find a significant kink effect of the likelihood of asset impairment loss recognition with respect to the BTM ratio, consistent with prior research and verifying our key identifying variation.

[23] The small dots in the figure represent the average indicator of impairments of 10 non-overlapping windows within the optimal bandwidth. Note that the selection of the number of non-overlapping windows does not affect the estimation of kink effect or the solid line in the figure. This is because the number of bins are selected after the optimal bandwidth and the kink effects are estimated, which is done only for the purpose of clean graphical representation with confidence intervals.

Similarly, Panel B shows the kink effects using the amount of asset impairment losses in period *t*+1 with respect to the BTM ratio at the end of period *t*. Overall, these figures demonstrate a significant kink in recognition of asset impairments at the BTM ratio equal to 1.

We then use the nonparametric approach to estimate the economic and statistical significance of the kink effects observed in Figure 2. Panel A in Table 3 presents the kink effect of the BTM ratio on the likelihood of asset impairment loss recognition. The outcome variable is an indicator variable equal to 1 if the firm recognizes goodwill or long-lived asset impairments in period *t*+1. Following Calonico et al. (2014) and Calonico et al. (2017), we employ a nonparametric local 1-order polynomial regression kink model.[24] Using the observations within the narrow window around the kink point (the optimal bandwidth is 0.101 on each side), we find a significant and positive kink, consistent with findings in Lawrence et al. (2013). The coefficient estimate suggests that the slope difference between the right- and left-hand sides of the kink point is 0.851. This estimate indicates that the sensitivity of the likelihood of impairment loss recognition to the BTM ratio increases by 0.851% (= 0.851 ×0.01) for a 1% increase of the BTM ratio when the BTM ratio exceeds 1 relative to when the BTM ratio is less than 1. In Panel B, we use the amount of asset impairment losses as an outcome variable and find a consistent positive increase of slope when the BTM ratio exceeds 1 (slope difference at kink point = 0.200).

In sum, we document that the likelihood of future asset impairments and the amount of those impairment losses increase at the narrow window around the BTM ratio equal to 1. These findings show that the BTM ratio equal to 1 is the point where the application of the asset impairment model is triggered, validating our identifying assumption.

4.2.3. Kink effects on monitoring activities

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[24] In Appendix D, we check the robustness of our primary results using the nonparametric local 2-order polynomial regression model. We document consistent results.

In this section, we examine the kink effects of the asset impairment model on monitoring activities. We first examine shareholder voting as a proxy for shareholder engagement to correct agency problems. Specifically, we focus on shareholders' responses to management-initiated proposals because prior studies show that these proposals represent the vast majority of voting activity for shareholders and provide clear opportunities for shareholders to voice their concerns to management (Iliev et al. 2015).[25] Active investors engage in information gathering and communicate with management and corporate boards to make informed decisions, and proxy advisors collect decision-relevant information to inform shareholders to perform delegated monitoring and complement shareholder engagement (Cai et al. 2009; Ertimur et al. 2013; McCahery et al. 2016). Prior literature provides ample evidence that dissident votes discipline managers and deter inefficient investment and corporate governance decisions (Becht et al. 2016; Li et al. 2018; Aggarwal et al. 2019). Hence, this test directly addresses the regulatory debate on whether the asset impairment model improves the principals' information set and thus facilitates shareholder engagement. We do not distinguish the shareholder voting agenda items (e.g., director election, executive compensation structure, audit-related issues, shareholder rights, and so forth) in this test because the extent to which agency problems revealed by the asset impairment tests are multi-faceted and manifested in various dimensions of governance issues.

Using management-initiated proposals, we construct two measures. First, the $\textit{Objected Proposals}_{t+1}$ variable is the number of management-initiated proposals for which ISS recommends

[25] Shareholder-initiated proposals are quite rare and generally indicative of unique firm situations (Iliev et al. 2015; McCahery et al. 2016). McCahery et al. (2016) provide a potential reason why shareholder-initiated proposals are rare. They find that private discussion of institutional investors with management is widely used and, thereby, many shareholder-initiated proposals are eventually withdrawn before a shareholder meeting. Also, McCahery et al. (2016) note that, even though the shareholder proposal indicates increased monitoring, it also signals a failure of governance because it indicates that a shareholder could not negotiate with management behind the scenes. McCahery et al. (2016) document that submissions of shareholder proposals have been used by only 16% of their respondents. In untabulated tests, we combine shareholder-initiated proposals that are supported by ISS with manager-initiated proposals that are not supported by ISS and find results consistent with Table 4.

a withhold, against, or no vote and which receives more than 20 percent of dissident shareholder votes, i.e., "Voted against" and "Voted abstain" (e.g., Aggarwal et al. 2019).[26] Second, the *Voting % of Objected Proposals*$_{t+1}$ is a continuous variable measuring the percentage of shareholder voting in the *Objected Proposals*$_{t+1}$.

To corroborate our inference, we additionally examine forced CEO turnover, which is the board's key corrective action. The asset impairment process is verified by auditors and overseen by audit committees (Stein 2019; Shepardson 2019), and thus it directly enriches the information set of the board. Poorly performing managers who refuse to leave the firm are the costliest manifestation of agency problems (Jensen and Ruback 1983). Therefore, one of the primary purposes of governance mechanisms is to remove poorly performing managers, and detailed information regarding the underlying agency problems plays a key role in this process (Gibson 2003; Armstrong et al. 2010). The asset impairment test can provide corporate boards with opportunities to acquire detailed information regarding key agency problems, and thereby it would facilitate their forced CEO turnover decisions.

One caveat in the forced CEO turnover test is, however, that the forced turnover event is rare because it is an extreme form of corporate governance mechanism. Prior research shows that only about 2% of CEOs are fired each year (Huson et al. 2001; Peters and Wagner 2014). Even though the low frequency indicates a clearer sign of the board taking corrective action, it empirically leads to a decreased statistical power to detect the treatment effects. Note also that, we focus on a narrow window surrounding BTM ratio equal to 1 in our identification strategy, further decreasing the empirical power to detect the treatment effects on forced CEO turnover in RKD.

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[26] Aggarwal et al. (2019) find that approximately 20% of votes are withheld by shareholders when ISS is against the management-initiated proposals. Thus, we classify an agenda item receiving more than 20% of withheld shareholder votes as a significant agenda item that has dissident shareholder voting. Our inference is qualitatively similar if we use all ISS recommendations that are against management-initiated proposals.

Figure 3 provides a graphical illustration of how the sensitivity of shareholder voting (CEO turnover) to the BTM ratio evolves around the cutoff point where the BTM ratio equals 1. Figures A and B plot the kink effects for shareholder voting, and Figure C illustrates the kink effect for forced CEO turnovers. The Y-axis is the measure of shareholder voting or forced CEO turnovers in period *t*+1, and the X-axis is the BTM ratio at the end of period *t*. All observations are restricted to those lying within the respective optimal bandwidth. These figures support our prediction that, due to the improved information set stemming from the application of the asset impairment model, the pattern of monitoring activities with respect to the BTM ratio within the narrow window around the kink point follows the pattern of the asset impairment function presented in Figure 2.

Table 4 presents the nonparametric estimation results for the kink effect on shareholder voting. First, in Panel A, we use observations lying within the optimal bandwidth (i.e., between 0.142 on each side) and find a positive and significant kink in $\textit{Objected Proposals}_{t+1}$ at the kink point. The coefficient estimate suggests that the slope difference between the right- and left-hand sides of the kink point is 0.895. Based on equation (3), we estimate the economic magnitude of the effect of recognizing future asset impairments on shareholder monitoring intensity:

$$\textit{Treatment effect} = \partial \textit{Monitoring Intensity}_{t+1} / \partial \textit{Asset Impairment Likelihood}_t$$
$$= (\hat{\beta}^{+}_{monitor} - \hat{\beta}^{-}_{monitor}) / (\hat{R}^{+}_{impair} - \hat{R}^{-}_{impair}) \quad (4)$$

where $\textit{Monitoring Intensity}_{t+1}$ is the monitoring intensity measures. $(\hat{R}^{+}_{impair} - \hat{R}^{-}_{impair})$ is the change in the sensitivity of the likelihood of recognizing future asset impairments to the BTM ratio around the kink point (i.e., the kink estimate in Panel A in Table 3). $(\hat{\beta}^{+}_{monitor} - \hat{\beta}^{-}_{monitor})$ is the change in the sensitivity of shareholder monitoring to the BTM ratio around the kink point (i.e., the kink estimates in Table 4). The economic magnitude suggests that when the BTM ratio exceeds 1, a 1% increase in the likelihood of recognizing future asset impairments would lead to a 1.05%

(= 0.01 ×0.895 / 0.851) increase in the total number of management-initiated proposals that receive unfavorable ISS recommendations and have significant dissident shareholder voting outcomes. In column (2), we use *Voting % of Objected Proposals* $_{t+1}$, the percentage of *Objected Proposals*$_{t+1}$, and find a similarly positive and significant kink at the kink point (slope difference at kink point = 0.218).

Next, we examine the kink effect on forced CEO turnover. Panel B in Table 4 shows the estimation result based on the optimal bandwidth (i.e., between 0.212 on each side). We find that the sensitivity of CEO turnover to the BTM ratio also exhibits a positive and significant kink (10% level) when the BTM ratio exceeds 1. As aforementioned, we note that the statistical significance is weaker than the shareholder voting result. Albeit weaker statistical significance, the economic magnitude is reasonable and significant: the slope difference at the kink point is 0.174, suggesting that a 1% increase in the future asset impairment leads to a 0.2 % (= 0.01 ×0.174 / 0.851) increase in forced CEO turnover. Overall, the findings support our prediction that principal monitoring intensity increases due to the more stringent application of the asset impairment model.

4.2.4. Kink effects on R&D investments

Next, we examine whether a firm's R&D activities exhibit positive slope changes when the BTM ratio of the firm exceeds 1. Figure 4 Panel A provides a graphical illustration of the kink effects of R&D expenditures. The Y-axis is the R&D expenditures in period t+1, and the X-axis is the BTM ratio at the end of period t. In Panel A, we find a sharp kink in R&D expenditures when the BTM ratio equals 1, suggesting a structural break in firms' R&D investments in response to the more stringent application of the asset impairment model.

Table 5 Panel A presents the nonparametric estimation results based on R&D expenditures. Using observations lying within the optimal bandwidth (i.e., between 0.277 on each side), we find a positive and significant kink in R&D expenditures when the BTM ratio equals 1. The kink estimate suggests that the slope difference between the right- and left-hand sides of the kink point is 0.203. We use this slope change and employ the following equation to estimate the economic magnitude:

$$\textit{Treatment effect} = \partial \textit{Investments}_{t+1} / \partial \textit{Asset Impairment Likelihood}_t$$
$$= (\hat{\beta}^{+}_{Inv} - \hat{\beta}^{-}_{Inv}) / (\hat{R}^{+}_{impair} - \hat{R}^{-}_{impair}) \quad (5)$$

where $\textit{Investments}_{t+1}$ is the investment outcomes, $(\hat{R}^{+}_{impair} - \hat{R}^{-}_{impair})$ is the change in the sensitivity of the likelihood of recognizing future asset impairments to the BTM ratio around the kink point (i.e., kink estimate in Panel A of Table 3), and $(\hat{\beta}^{+}_{inv} - \hat{\beta}^{-}_{inv})$ is the change in the sensitivity of R&D activities to the BTM ratio around the kink point (i.e., the kink estimate in Table 5). The economic magnitude suggests that a 1% increase in the likelihood of recognizing impairment losses leads to a 0.24% (= 0.01 × 0.203 / 0.851) increase in R&D expenditures when the BTM ratio exceeds 1.

4.2.5. Kink effects on over-investments

In this section, we test whether the application of the asset impairment model discourages managers from over-investments. In doing so, we construct an indicator of over-investment in capital expenditures and acquisitions (e.g., Biddle et al. 2009). First, we estimate the regression of investments in period t+1 on sales growth in period t (i.e., $\textit{Investment}_{t+1} = \beta_0 + \beta_1 \textit{Sales Growth}_t + \varepsilon$). $\textit{Investment}_{t+1}$ is the sum of capital expenditures and acquisitions less cash receipts from the sale of property, plant, and equipment in period t+1 multiplied by 100 and scaled by lagged total assets. $\textit{Sales Growth}_t$ is measured as the percentage change in sales from period t-1 to period t and multiplied by 100. Second, we estimate this regression model for each industry-year based on the three-digit SIC industry classification. We require at least 20 observations for each estimation.

Lastly, we sort firms into 5 quantiles based on the magnitude of the residuals. $\textit{Over-investment}_{t+1}$ is equal to 1 for the firm-year observations that belong to the top quantile and 0 otherwise.

Figure 4 Panel B provides a graphical illustration of the kink effects of the incidence of over-investment with respect to the BTM ratio. Consistent with our expectation, the figure shows a structural reduction in firms' sensitivity of the over-investment in capital expenditures and acquisitions to the BTM ratio when the BTM ratio exceeds 1.

Table 5 Panel B reports the nonparametric estimation results. Using observations lying within the optimal bandwidth (i.e., between 0.132 on each side), we find a negative and significant kink in the over-investment indicator at the kink point. The slope difference at the kink point is equal to -0.611, suggesting that a 1% increase in the likelihood of future asset impairments leads to a 0.72% (= 0.01 × 0.611 / 0.851) decrease in over-investments.

Unlike OLS estimation, nonparametric RKD is not affected by the functional form and therefore generates more reliable statistical inferences. Note that RKD relies on cross-sectional variations rather than within-firm time-series changes. To check whether our findings are robust in a regular OLS estimation, in Appendix E we alternatively use a pooled OLS regression specification and examine the sensitivity changes at BTM ratio equal to 1 for R&D and over-investments around the time of the change in SFAS 121 implemented in 1995. Prior to the implementation of SFAS 121 in 1995, there was no authoritative guidance for management on the recognition, measurement, and disclosure of asset impairments. Because we include the pre-SFAS 121 period in this test, we exclude shareholder monitoring variables and forced CEO turnover due to data limitations. $\textit{Post}_t$ is an indicator equal to 1 if the period is after 1995, and zero otherwise. $\textit{BTMD}_t$ is an indicator equal to 1 if the BTM ratio of assets exceeds 1, zero otherwise. We interact these two variables with the BTM ratio. We document consistent results using pooled OLS regression, i.e., positive sensitivity changes for R&D and negative sensitivity changes for over-investments when the BTM ratio exceeds 1 ($BTM_t \times BTMD_t \times Post_t$) in the post-SFAS 121 period.

5. Additional Tests

5.1. RKD estimation results using ad hoc bandwidths

In our main tests, we employ an optimal bandwidth estimation (Calonico et al. 2014; Calonico et al. 2017). In this section, we perform sensitivity checks by examining how the estimation results of kink effects vary with changes in bandwidth. We use a polynomial order of 1 and change the bandwidths from 0.15 to 0.2 with the increment of 0.1 for both the left and right sides of the kink point. Table 6 presents the estimation results. Using different bandwidths, we have slightly different kink estimates. However, we continue to find kink estimates consistently showing that the sensitivities of monitoring and investment variables to the BTM ratio exhibit statistically significant kinks at the kink point. We note that forced turnover exhibits statistically insignificant results as we narrow our bandwidth. As aforementioned, this is expected given that forced turnover is rare and the extreme form of corporate governance mechanism. Although the kink effects on CEO turnover are statistically weaker in more narrow bands, we note that the magnitudes of kink are stable across different ad hoc bandwidths. In sum, these findings suggest that our findings are robust to alternative definitions of ad hoc bandwidth.

5.2. Falsification test: Kink effects in pre-asset impairment periods

In our main analysis, we rely on a two-step analysis of accounting regulation of asset impairments comparing the book value of assets with the market value of assets. However, the BTM ratio may be correlated with unobservable factors, which may also drive a significant kink effect around the kink point. To alleviate this concern, we examine whether there is a significant kink around the kink point for forced CEO turnover, R&D, and over-investment in capital expenditure and acquisitions from 1986 to 1994 when the asset impairment rules were not in effect. SFAS 121 was implemented in 1995, which provided management with authoritative guidance on the recognition, measurement, and disclosure of asset impairments.[27, 28] Hence, after the adoption of SFAS 121, GAAP for asset impairments has been formalized (Lawrence et al. 2013). Before its adoption, both long-lived tangible and intangible assets were recognized as an asset and amortized over no longer than 40 years. Thus, we do not expect to observe significant kink effects in the pre-asset impairment regulation periods.

Table 7 presents the estimation results in the pre-SFAS 121 periods. Consistent with our expectations, we find insignificant kink effects in the outcome variables. These findings suggest that the application of the asset impairment model generates the kink effects in the firm's monitoring and investment activities.

5.3. Alternative explanation: Growth opportunities or behavioral reasons

We note the possibility that growth opportunities or investors' increased attention driven by some behavioral reasons (i.e., BTM ratio as a 'focal point') could be correlated with the BTM ratio of assets. Therefore, even without the asset impairment model, those alternative channels might also yield kink effects on monitoring and investment activities.[29] To alleviate this concern,

[27] Because shareholder proposal data is available only from 2003, we are not able to conduct tests for $Objected\ Proposals_{t+1}$ and $Voting\ \%\ of\ Objected\ Proposals_{t+1}$. Also, because the forced CEO turnover data is available only from 1992, we test from 1992 to 1994 for forced CEO turnover.

[28] We conduct similar untabulated tests from 1995 to 2001, when the asset impairment rules on intangible assets including goodwill were not yet introduced (i.e., SFAS 142 in 2002). We find results qualitatively similar to those of the pre-1995 period. Prior research suggests that agency problems play a significant role in intangible assets impairments as it involves more subjective estimates and assumptions (e.g., Francis et al. 1996; Ramanna and Watts 2012). Also, SFAS 142 requires the joint evaluation of goodwill and other non-goodwill net assets in the impairment test of goodwill. Thus, our finding highlights the importance of impairment accounting for intangible assets (e.g., goodwill) and indicates that effects on monitoring and investments that we document in our main analysis are primarily caused by asset impairment tests on intangible assets.

[29] Note that there are no theoretical foundations supporting those alternative forces to generate 1) structural breaks of slope changes at BTM of assets equal to 1 and 2) the prediction of "increase" in monitoring and investment efficiency.

we use the BTM ratio of equity instead of the BTM ratio of assets as an assignment variable and estimate the kink effects. Theoretically, like the BTM ratio of assets, the BTM ratio of equity should also capture the growth opportunities of a firm or changes in investors' behavior. Therefore, if our findings are indeed driven by unobservable factors rather than the asset impairment model, using the BTM ratio of equity as an assignment variable should yield similar kink effects around the same kink point.

Table 8 presents the estimation results. We note that one empirical challenge in using the BTM ratio of equity as an assignment variable is that optimal bandwidths based on the data structure are approximately three times larger than those used in our previous tests using the BTM ratio of assets. A large bandwidth would lead to a concern about potential biases in estimating local treatment effects. To alleviate this concern, in columns 1 to 3 of each panel, we use narrow ad hoc bandwidths (i.e., 0.1, 0.15, or 0.2) to enhance the accuracy of the local treatment effect estimation. In column 4 of each panel, we use optimal bandwidths for each test to check the robustness of our findings. The results suggest that using the BTM ratio of equity as an assignment variable does not yield any significant kink effects on asset impairments (panels A and B), monitoring intensity (panels C, D, and E), R&D expenditures (Panel F), or over-investments in capital expenditures and acquisitions (Panel G) at the kink point.[30] Overall, the findings in Table 8 strengthen our inference and suggest that our findings are not driven by a structural change in unobservable growth opportunities or behavioral reasons when the BTM ratio of assets equals 1.

5.4. Comparison between impairment sample and non-impairment sample

[30] In Panel C Column 1, we find a statistically significant kink effect on the number of management proposals opposed by shareholders. Note that even though this kink effect at this ad hoc bandwidth (0.1) is statistically significant, we find statistically insignificant results using other ad hoc bandwidths and, more importantly, the optimal bandwidth. Thus, we can reach a conclusion that monitoring intensity and investment changes are due to the application of the asset impairment model rather than other confounding factors (e.g., growth opportunities).

In our identification strategy, we do not rely on the actual asset impairments to identify a setting where the stringent application of the asset impairment model is triggered. The final decision on the incidence and the amount of asset impairment charges does not reflect the principals receiving the timely information as it is affected by managerial discretion and opportunism after receiving the additional information (Riedl 2004; Beatty and Weber 2006; Ramanna and Watts 2012; Li and Sloan 2017). This implies that, principals' information set was already significantly altered, and many corrective actions were likely to be made before the asset impairment charges are recognized in the financial statements. If this is indeed the case, we expect to find that our kink results are less pronounced for sample firms that recognized asset impairments in the prior period. Consistent with our expectation, in Table 9, we find that our primary findings are less pronounced and insignificant for firms that reported the asset impairments in the prior period. These findings corroborate our identification strategy and strengthen our key inferences.

5.5. Alternative explanation: Earnings management

Prior literature documents that managers use discretion to delay the recognition of asset impairments. Also, Rees et al. (1996) find that firms taking asset impairments record significant abnormal accruals. In this case, one alternative explanation behind our results could be earnings management: managers engage in earnings management to lower the BTM ratio. Firms with the BTM ratio slightly smaller than 1 would be those with a higher likelihood of earnings management compared to those with the BTM ratio slightly greater than 1. If so, these firms are more likely to be associated with less monitoring and greater myopia on their investment decisions. Therefore, if those earnings management incentives around the BTM ratio equal to 1 drive the kink results of monitoring and investments, we would expect to see a negative kink at the BTM ratio equal to 1.

To rule out this potential alternative explanation, we examine whether performance-matched discretionary accruals exhibit a negative kink at the BTM ratio equal to 1. Table 10 presents the estimation results. We examine kink effects for discretionary accruals in period *t*+1, period *t*, and period *t*-1 using ad hoc bandwidths of 0.1, 0.15, and 0.2, and optimal bandwidth. In all specifications, we do not find any statistically significant kink effects. Overall, the findings in Table 10 strengthen our inference and suggest that our findings are not driven by a structural change in earnings management incentives when the BTM ratio of assets equals 1.

5.6. Alternative explanation: Disclosing previously hidden R&D

Koh and Reeb (2015) show that firms may strategically hide their real R&D expenditures due to proprietary costs. They describe these firms with undisclosed patent activities as "pseudo-blank R&D firms." In our setting, one alternative explanation would be that firms could be incentivized to disclose the previously hidden R&D expenditures in response to the increased likelihood of future asset impairments, leading to a positive kink effect on the reported R&D expenditures. In this case, the observed increase in R&D expenditures merely reflects changes in the disclosure strategy of the firm rather than real investment behavior.

To rule out this alternative explanation, we directly examine the kink effects on the likelihood of a firm having pseudo-blank R&D. In Table 11, surprisingly, we find the opposite result: there is a positive and significant kink effect on pseudo-blank R&D, implying that, instead of disclosing previously hidden R&D expenditures, firms choose to hide more R&D activities. This finding is consistent with the increased proprietary costs of disclosure due to higher innovative and value-enhancing activities when the likelihood of recognizing future asset impairments increases.

5.7. Implications on productivity: Patent filings and patent value

In the previous subsections, we provide evidence that the more stringent application of the asset impairment model results in increased R&D investments. We also attempt to rule out alternative explanations and show that our findings are robust. In this last subsection, we go one step further and draw implications for the long-run productivity of firms. We examine whether the increased R&D expenditures and reduced over-investments in capital expenditures and acquisitions have desirable outputs in the long run. To this end, we estimate the kink effects on future patent filing activities and patent quality proxied by the patent value when firms' BTM ratios exceed 1. If our conjecture is correct (i.e., an increase in R&D activities arises from managerial efforts to increase firm value), we expect to observe an increase in patent activities and patent quality in the long run.

Table 12 examines the kink effects on yearly patent filing activities from period *t*+1 to period *t*+3 using samples lying within the optimal bandwidth (i.e., between 0.175 on each side). In column (1), we find a positive and significant kink effect on patent activities during period *t*+1 to period *t*+3 at the kink point, consistent with our expectation. The slope difference between the right- and left-hand sides of the kink point is 2.586. In column (2), we use observations lying within the optimal bandwidth (i.e., between 0.174 on each side) and also find a positive and significant kink effect on the patent value from period *t*+1 to period *t*+3 at the kink point.

6. Conclusion

We use a nonparametric local polynomial regression kink design and examine whether the application of the asset impairment model affects firms' monitoring and investment activities. We exploit the unique feature of the asset impairment accounting rules guided by SFAS 142 and 144 in which the sensitivity of the asset impairment recognition to the BTM ratio of assets exhibits a structural break around the kink point of the BTM ratio equal to 1. Using nonparametric RKD estimation, we provide evidence that monitoring and investment activities increase with the extent to which the more stringent application of the asset impairment model is triggered. We also find increased shareholder engagement, forced CEO turnovers, and R&D investments but decreased over-investments in capital expenditures and acquisitions. Our findings support the notion that the asset impairment accounting model plays a positive role in corporate governance and changing a firm's growth policies, moving away from myopic investments to value-enhancing investments.

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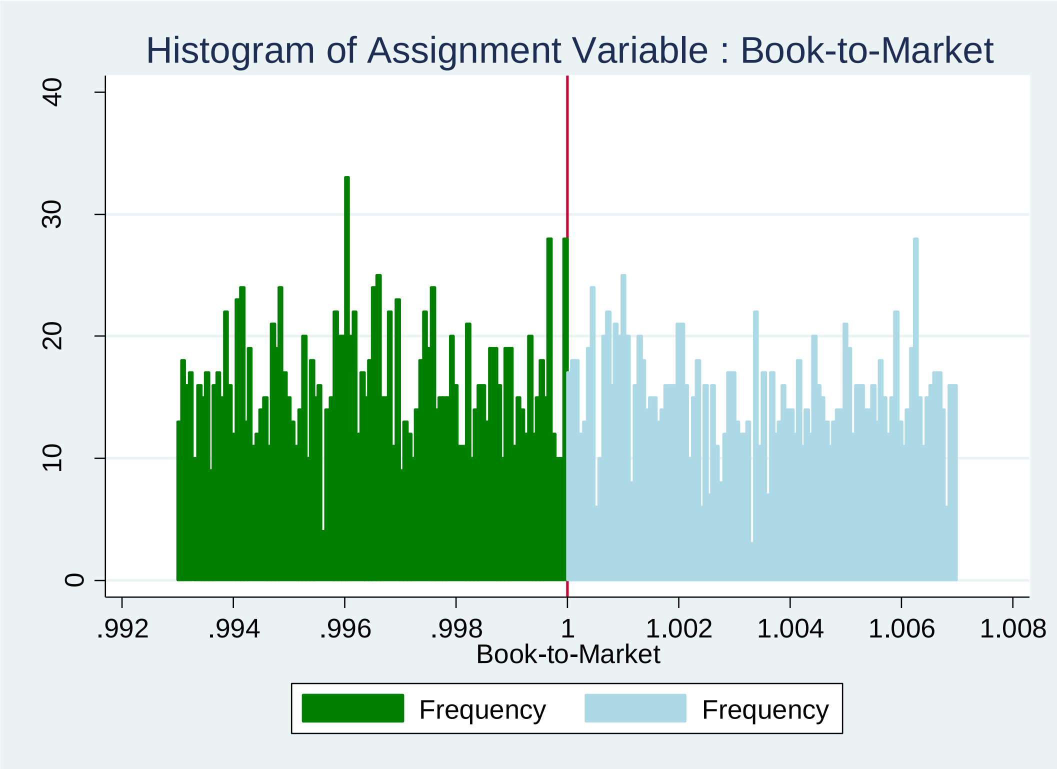
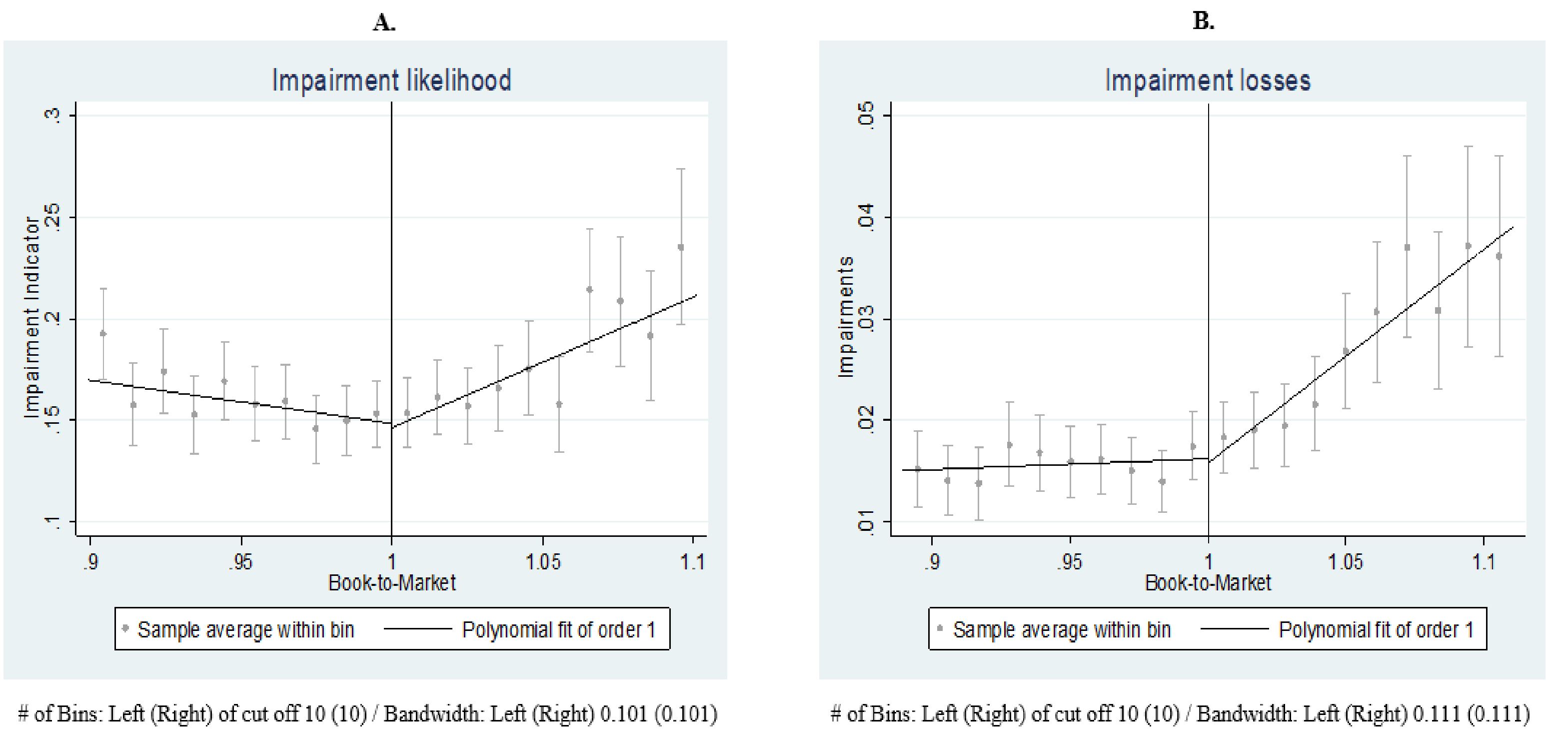
Figure 1. Histogram of assignment variable: Book-to-market ratio (BTM)



This figure shows the density of the BTM ratio. Regression kink design can be invalid if individuals can *precisely* manipulate the assignment variable, i.e., the BTM ratio (Lee and Lemieux 2010). We graphically test the smoothness of the distribution of the assignment variable (BTM_t) at the kink point, i.e., BTM_t = 1. Figure 1 is the graphical representation of the underlying histogram using the bandwidth estimated from Table 1 (i.e., 0.007) and the number of bins of 100.

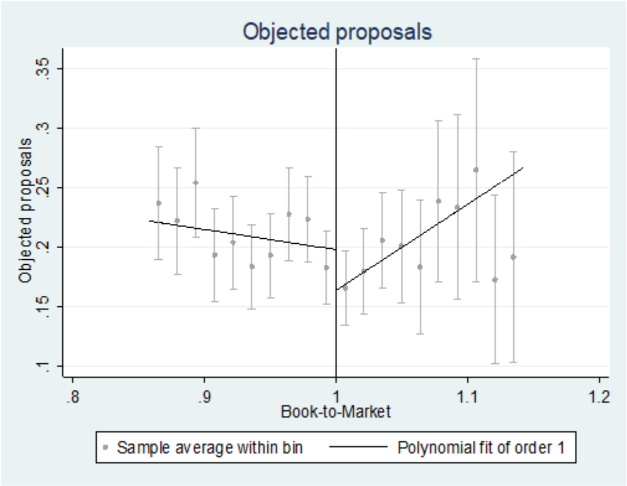
Figure 2. Asset impairments around BTM equal to 1



This figure illustrates the kink effects on asset impairments. Figure A shows the kink effect on the indicator of asset impairments in period *t+1* (*Impairment Indicator*$_{t+1}$). Figure B shows the kink effect on asset impairment losses in period *t+1* (*Impairments*$_{t+1}$). In Figure A, the plot is the average indicator of impairments with a 95% confidence interval when the number of bins is equal to 10 for both left and right of the kink point. In Figure B, the plot is the average impairment losses with a 95% confidence interval when the number of bins is equal to 10 for both left and right of the kink point. The lines display predicted values of the local 1-order polynomial model within the optimal bandwidth. The optimal bandwidth is calculated following Calonico et al. (2014) and Calonico et al. (2017).

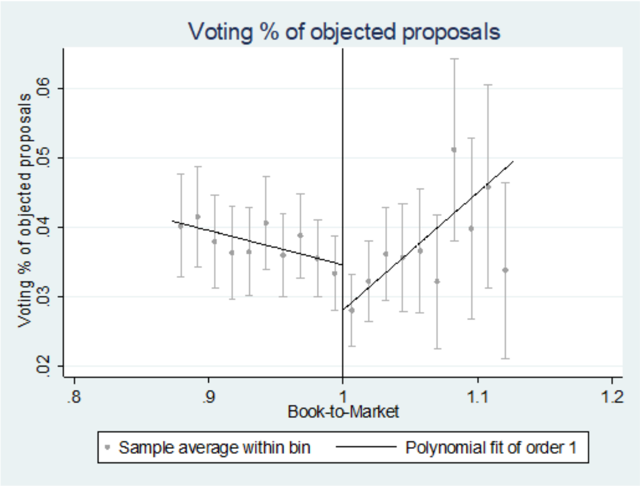
Figure 3. Shareholders' monitoring intensity around BTM equal to 1

A.



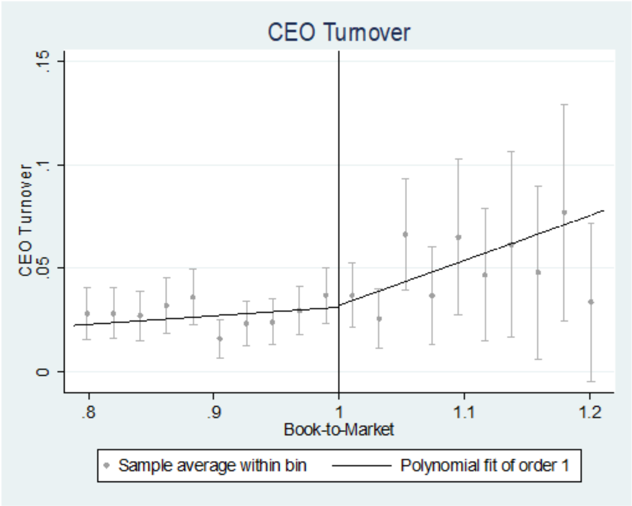
# of Bins: Left (Right) of cut off 10 (10) / Bandwidth: Left (Right) 0.142 (0.142)

B.



# of Bins: Left (Right) of cut off 10 (10) / Bandwidth: Left (Right) 0.127 (0.127)

C.

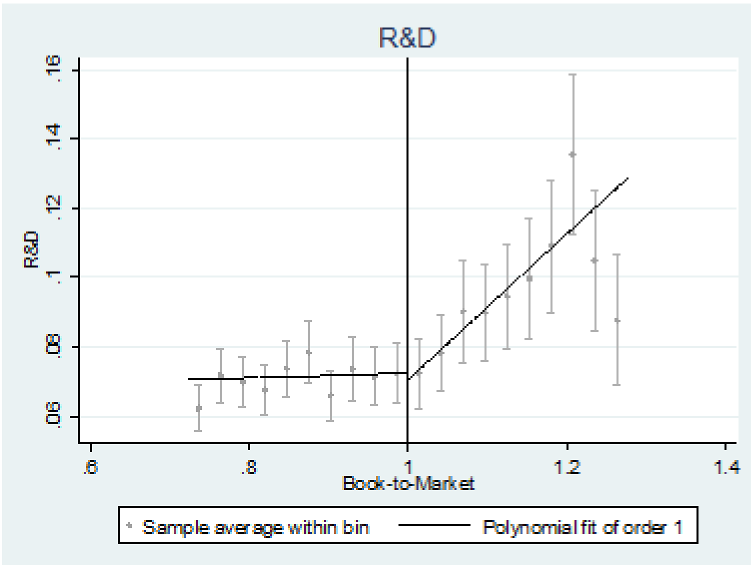


# of Bins: Left (Right) of cut off 10 (10) / Bandwidth: Left (Right) 0.212 (0.212)

This figure illustrates the kink effects on monitoring intensity by principals. Figure A. shows the kink effect on the number of proposals supported by managers, but Institutional Shareholder Services (ISS) recommend voting against in period *t+1* (*Objected Proposals*$_{t+1}$). Figure B shows the kink effect on the percentage of votes against the managers' proposals in period *t+1* (*Voting % of Objected Proposals*$_{t+1}$). Figure C shows the kink effect on forced CEO turnover in period *t+1* (*Forced Turnover*$_{t+1}$). In Figure A, the plot is the average number of proposals with a 95% confidence interval when the number of bins is equal to 10 both left and right of the kink point. In Figure B, the plot is the average percentage of votes against with a 95% confidence interval when the number of bins is equal to 10 both left and right of the kink point. In Figure C, the plot is the average forced turnovers with a 95% confidence interval when the number of bins is equal to 10 for both left and right of the kink point. The lines display predicted values of the local 1-order polynomial model within the optimal bandwidth. The optimal bandwidth is calculated following Calonico et al. (2014) and Calonico et al. (2017).

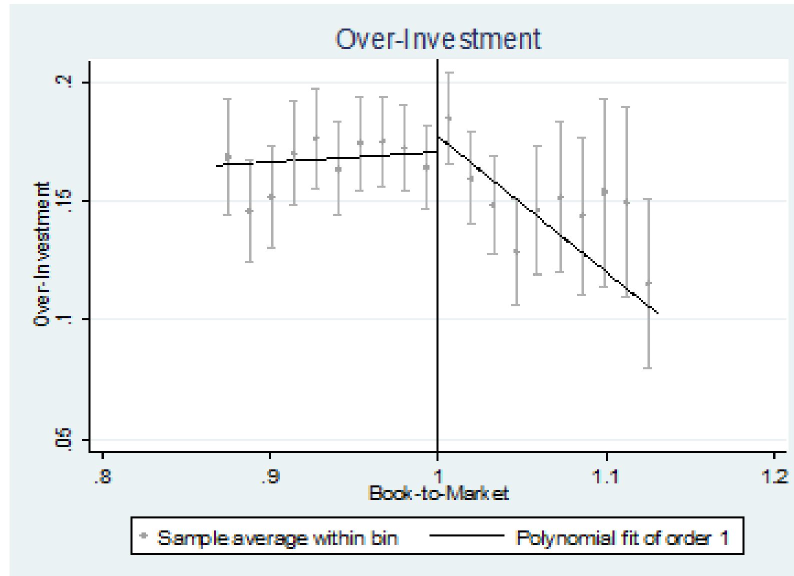
Figure 4. Investments around BTM equal to 1

A.



# of Bins : Left (Right) of cut off 10 (10) / Bandwidth: Left (Right) 0.277 (0.277)

B.



# of Bins : Left (Right) of cut off 10 (10) / Bandwidth: Left (Right) 0.132 (0.132)

Figure A illustrates the kink effects on R&D in period *t+1* (*R&D* $_{t+1}$). The plot is the average amount of R&D expenditures with a 95% confidence interval when the number of bins is equal to 10 both left and right of the kink point. Figure B shows the kink effect on over-investments in period *t+1* (*Over-Investment* $_{t+1}$). The plot is the average indicator of over-investment in period *t+1* with a 95% confidence interval when the number of bins is equal to 10 both left and right of the kink point. The lines display predicted values of the local 1-order polynomial model within the optimal bandwidth. The optimal bandwidth is calculated following Calonico et al. (2014) and Calonico et al. (2017).

Table 1. Continuous density tests

This table presents the results from continuous density tests of the assignment variable (BTM_t) at the kink point of the BTM ratio equal to 1 (i.e., manipulation tests using local polynomial density estimation). We test discontinuity using the nonparametric local 1-order polynomial model, i.e., polynomial order = 1, and local 2-order polynomial order, i.e., polynomial order = 2. The discontinuity of density is tested by estimating optimal bandwidth and using a triangular kernel function to provide more weights on the observations closer to the kink point. We follow Calonico et al. (2014) and Calonico et al. (2017) to estimate an optimal bandwidth.

	Local Polynomial Order =1		Local Polynomial Order =2	
	Left of Kink point	Right of Kink point	Left of Kink point	Right of Kink point
Eff. Number of Obs.	1,176	1,101	11,395	8,719
Bandwidth Values	0.007	0.007	0.072	0.072
Kernel Function	Triangular	Triangular	Triangular	Triangular
p-value	0.116		0.603	

Table 2. Descriptive statistics

This table presents descriptive statistics. The sample period ranges from 2002 to 2015 for the main analyses. All continuous variables are winsorized at 1% and 99%. Appendix A provides variable descriptions.

	N	Mean	Stdev	25th	50th	75th
BTM_t	114,964	0.714	0.417	0.411	0.716	0.968
$Impairment\ Indicator_{t+1}$	114,964	0.168	0.374	0	0	0
$Impairments_{t+1}$	114,964	0.015	0.070	0	0	0
$Objected\ Proposals_{t+1}$	62,176	0.225	0.708	0	0	0
$Voting\ \%\ of\ Objected\ Proposals_{t+1}$	62,176	0.043	0.118	0	0	0
$Forced\ Turnover_{t+1}$	27,323	0.027	0.161	0	0	0
$R\&D_{t+1}$	48,155	0.074	0.133	0.002	0.027	0.085
$Over\text{-}Investment_{t+1}$	68,567	0.197	0.398	0	0	0
$Patents_{t+1,\ t+3}$	73,860	0.543	1.168	0	0	0.693
$Patent\ Value_{t+1,\ t+3}$	73,860	0.425	0.920	0	0	0.162
$Disc\ Accruals_t$	78,259	-0.0004	0.279	-0.083	0	0.083
$Missing\ R\&D_{t+1}$	114,964	0.056	0.229	0	0	0

Table 3. Kink effect on asset impairments

This table examines whether the impairment loss recognition in period *t+1* exhibits a kink at the BTM ratio equal to 1 in period *t*. Panel A examines the kink effects on the likelihood of impairment loss recognition. Panel B examines the kink effects on the amount of asset impairments. We compare the slope estimated from samples lying on the right-hand side of the kink point and the slope estimated from those lying on the left-hand side of the kink point. In Panel A, the outcome variable is the indicator variable of goodwill impairment or long-lived asset impairment recognition in period *t+1* ($Impairment\ Indicator_{t+1}$). In Panel B, the outcome variable is the total amount of the goodwill impairments and the long-lived asset impairments in period *t+1* ($Impairments_{t+1}$). The assignment variable is the BTM ratio in period *t* (BTM_t). The bandwidth and the estimated kink effects are optimally calculated following Calonico et al. (2014) and Calonico et al. (2017) using the nonparametric local 1-order polynomial model (i.e., polynomial order = 1). Standard errors are adjusted for heteroscedasticity and three nearest neighbor observations. Appendix A provides detailed variable descriptions.

Panel A. The likelihood of impairment loss recognition

	$Impairment\ Indicator_{t+1}$
Estimation	
Estimated Kink	0.851***
Std. Error	0.211
P-value	0.000
Left of Cutoff (BTM = 1)	
Bandwidth	0.101
Eff. Number of Obs.	14,987
Right of Cutoff (BTM = 1)	
Bandwidth	0.101
Eff. Number of Obs.	10,289
Kernel Function	Triangular

Panel B. The asset impairment losses

	$Impairments_{t+1}$
Estimation	
Estimated Kink	0.200***
Std. Error	0.043
P-value	0.000
Left of Cutoff (BTM = 1)	
Bandwidth	0.111
Eff. Number of Obs.	16,206
Right of Cutoff (BTM = 1)	
Bandwidth	0.111
Eff. Number of Obs.	10,736
Kernel Function	Triangular

Table 4. Kink effect on the intensity of monitoring

This table examines whether the intensity of shareholder monitoring in period *t+1* exhibits a kink at the BTM ratio (BTM_t) equal to 1 in period *t*. Panel A examines the kink effects on shareholder voting. Panel B examines the kink effects on the likelihood of forced CEO turnover. We compare the slope estimated from samples lying on the right-hand side of the kink point and the slope estimated from those lying on the left-hand side of the kink point. In Panel A column (1), the outcome variable is the number of proposals supported by managers, but Institutional Shareholder Services (ISS) recommend voting against ($Objected\ Proposals_{t+1}$). In Panel A column (2), the outcome variable is the percentage of votes against manager proposals ($Voting\ \%\ of\ Objected\ Proposals_{t+1}$). In Panel B, the outcome variable is the indicator variable equal to 1 if there is a forced CEO turnover in period *t+1* ($Forced\ Turnover_{t+1}$). The bandwidth and the estimated kink effects are optimally calculated following Calonico et al. (2014) and Calonico et al. (2017) using the nonparametric local 1-order polynomial model (i.e., polynomial order = 1). Standard errors are adjusted for heteroscedasticity and three nearest neighbor observations.

Panel A. Number of manager proposals opposed by shareholders

	$Objected\ Proposals_{t+1}$	$Voting\ \%\ of\ Objected\ Proposals_{t+1}$
	(1)	(2)
Estimation		
Estimated Kink	0.895***	0.218***
Std. Error	0.325	0.059
P-value	0.006	0.000
Left of Cutoff (BTM = 1)		
Bandwidth	0.142	0.127
Eff. Number of Obs.	12,552	11,612
Right of Cutoff (BTM = 1)		
Bandwidth	0.142	0.127
Eff. Number of Obs.	7,046	6,807
Kernel Function	Triangular	Triangular

Panel B. Forced CEO Turnover

	$Forced\ Turnover_{t+1}$
Estimation	
Estimated Kink	0.174*
Std. Error	0.099
P-value	0.079
Left of Cutoff (BTM = 1)	
Bandwidth	0.212
Eff. Number of Obs.	7,330
Right of Cutoff (BTM = 1)	
Bandwidth	0.212
Eff. Number of Obs.	2,364
Kernel Function	Triangular

Table 5. Kink effects on investments

This table examines whether R&D in period *t+1* exhibit a kink at the BTM ratio (BTM_t) equal to 1 in period *t*. We compare the slope estimated from samples lying on the right-hand side of the kink point and the slope estimated from those lying on the left-hand side of the kink point. In Panel A, the outcome variable is R&D expenditures ($R\&D_{t+1}$). In Panel B, the outcome variable is the indicator of over-investment in capital expenditures and acquisitions in period *t+1* ($Over\text{-}investment_{t+1}$). The bandwidth and the estimated kink effects are optimally calculated following Calonico et al. (2014) and Calonico et al. (2017) using the nonparametric local 1-order polynomial model (i.e., polynomial order = 1). Standard errors are adjusted for heteroscedasticity and three nearest neighbor observations. Appendix A provides detailed variable descriptions.

Panel A. R&D Investments

	$R\&D_{t+1}$
Estimation	
Estimated Kink	0.203***
Std. Error	0.044
P-value	0.000
Left of Cutoff (BTM = 1)	
Bandwidth	0.277
Eff. Number of Obs.	10,593
Right of Cutoff (BTM = 1)	
Bandwidth	0.277
Eff. Number of Obs.	4,109
Kernel Function	Triangular

Panel B. Over-investments

	$Over\text{-}investment_{t+1}$
Estimation	
Estimated Kink	-0.611***
Std. Error	0.189
P-value	0.001
Left of Cutoff (BTM = 1)	
Bandwidth	0.132
Eff. Number of Obs.	13,185
Right of Cutoff (BTM = 1)	
Bandwidth	0.132
Eff. Number of Obs.	7,484
Kernel Function	Triangular

Table 6. RKD estimation based on ad hoc bandwidths

This table presents results from the sensitivity tests examining how the kink effects vary with changes in bandwidth. We use the nonparametric local 1-order polynomial model (Polynomial order equal to 1, kink point equal to 1) and present the kink estimation results as the ad hoc bandwidth changes from 0.15 to 0.2. P-values are in parentheses. Appendix A provides detailed variable descriptions.

	Impairment Indicator$_{t+1}$	*Impairments$_{t+1}$*	*Objected Proposals$_{t+1}$*	*Voting % of Objected Proposals$_{t+1}$*	*Forced Turnover$_{t+1}$*	*R&D$_{t+1}$*	*Over-investment$_{t+1}$*
Bandwidth	(1)	(2)	(3)	(4)	(5)	(6)	(7)
0.15	1.011***	0.192***	0.867***	0.187***	0.183	0.212**	-0.572***
	(0.000)	(0.000)	(0.004)	(0.000)	(0.22)	(0.031)	(0.000)
0.16	1.013***	0.188***	0.859***	0.18***	0.178	0.221**	-0.552***
	(0.000)	(0.000)	(0.002)	(0.000)	(0.197)	(0.013)	(0.000)
0.17	1.012***	0.183***	0.856***	0.174***	0.176	0.221***	-0.532***
	(0.000)	(0.000)	(0.001)	(0.000)	(0.171)	(0.007)	(0.000)
0.18	1.008***	0.178***	0.855***	0.17***	0.175	0.215***	-0.506***
	(0.000)	(0.000)	(0.001)	(0.000)	(0.145)	(0.004)	(0.000)
0.19	1.006***	0.174***	0.863***	0.168***	0.176	0.214***	-0.479***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.117)	(0.002)	(0.000)
0.2	0.999***	0.171***	0.884***	0.167***	0.179*	0.211***	-0.452***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.09)	(0.001)	(0.000)

Table 7. Kink effects in the pre-SFAS 121 period

This table examines whether forced CEO turnover, R&D, and over-investment in capital expenditures and acquisitions in period *t+1* exhibit kink at the BTM ratio equal to 1 in period *t* in the pre-SFAS 121 period between 1986 and 1994. We compare the slope estimated from samples lying on the right-hand side of the kink point and the slope estimated from those lying on the left-hand side of the kink point. The outcome variable is denoted at the top row of the table. The assignment variable is the BTM ratio in period *t* (BTM_t). The bandwidth and the estimated kink effects are optimally calculated following Calonico et al. (2014) and Calonico et al. (2017) using the nonparametric local 1-order polynomial model (i.e., polynomial order = 1). Standard errors are adjusted for heteroscedasticity and three nearest neighbor observations. Appendix A provides detailed variable descriptions.

	$Forced\ Turnover_{t+1}$	$R\&D_{t+1}$	$Over\text{-}investment_{t+1}$
	(1)	(2)	(3)
Estimation			
Estimated Kink	0.154	0.02	0.059
Std. Error	0.192	0.038	0.051
P-value	0.422	0.593	0.243
Left of Cutoff (BTM = 1)			
Bandwidth	0.167	0.3	0.426
Eff. Number of Obs.	1,227	7,935	19,703
Right of Cutoff (BTM = 1)			
Bandwidth	0.167	0.3	0.426
Eff. Number of Obs.	269	3,504	7,218
Kernel Function	Triangular	Triangular	Triangular

Table 8. BTM of equity as an assignment variable

This table examines whether impairment recognitions, impairment losses, objected proposals, percentage of voting against managers' proposals, R&D expenditures, and over-investment in capital expenditures and acquisitions in period *t+1* exhibit kink at the BTM ratio of *equity* equal to 1 in period *t*. We compare the slope estimated from samples lying on the right-hand side of the kink point and the slope estimated from those lying on the left-hand side of the kink point. In columns 1-3, we use bandwidth of 0.1, 0.15, and 0.2, respectively. In column 4, the bandwidth and the estimated kink effects are optimally calculated following Calonico et al. (2014) and Calonico et al. (2017) using the nonparametric local 1-order polynomial model (i.e., polynomial order = 1). Standard errors are adjusted for heteroscedasticity and three nearest neighbor observations. Appendix A provides detailed variable descriptions.

Panel A. Likelihood of impairment loss recognition

	Impairment Indicator$_{t+1}$			
	(1)	(2)	(3)	(4)
Estimation				
Estimated Kink	0.341	0.251	0.161	0.044
Std. Error	0.366	0.199	0.130	0.041
P-value	0.351	0.206	0.217	0.290
Left of Cutoff (BTM = 1)				
Bandwidth	0.1	0.15	0.2	0.449
Eff. Number of Obs.	4,601	7,250	10,028	28,843
Right of Cutoff (BTM = 1)				
Bandwidth	0.1	0.15	0.2	0.449
Eff. Number of Obs.	3,947	5,515	6,962	11,910
Kernel Function	Triangular	Triangular	Triangular	Triangular

Panel B. Asset impairment losses

	Impairments$_{t+1}$			
	(1)	(2)	(3)	(4)
Estimation				
Estimated Kink	-0.031	-0.028	-0.039	-0.004
Std. Error	0.08	0.042	0.027	0.007
P-value	0.7	0.508	0.156	0.527
Left of Cutoff (BTM = 1)				
Bandwidth	0.1	0.15	0.2	0.544
Eff. Number of Obs.	4,601	7,250	10,028	37,958
Right of Cutoff (BTM = 1)				
Bandwidth	0.1	0.15	0.2	0.544
Eff. Number of Obs.	3,947	5,515	6,962	13,164
Kernel Function	Triangular	Triangular	Triangular	Triangular

Panel C. Number of manager proposals opposed by shareholders

	Objected Proposals$_{t+1}$			
	(1)	(2)	(3)	(4)
Estimation				
Estimated Kink	1.532*	0.45	0.318	0.02
Std. Error	0.885	0.475	0.317	0.061
P-value	0.083	0.343	0.315	0.738
Left of Cutoff (BTM = 1)				
Bandwidth	0.1	0.15	0.2	0.676
Eff. Number of Obs.	2,635	4,200	5,871	32,149
Right of Cutoff (BTM = 1)				
Bandwidth	0.1	0.15	0.2	0.676
Eff. Number of Obs.	2,053	2,892	3,642	7,515
Kernel Function	Triangular	Triangular	Triangular	Triangular

Panel D. Percentage of votes against manager proposals

	Voting % of Objected Proposals$_{t+1}$			
	(1)	(2)	(3)	(4)
Estimation				
Estimated Kink	0.229	0.095	0.074	0.004
Std. Error	0.140	0.077	0.051	0.011
P-value	0.103	0.214	0.149	0.7
Left of Cutoff (BTM = 1)				
Bandwidth	0.1	0.15	0.2	0.628
Eff. Number of Obs.	2,635	4,200	5,871	28,903
Right of Cutoff (BTM = 1)				
Bandwidth	0.1	0.15	0.2	0.628
Eff. Number of Obs.	2,053	2,892	3,642	7,303
Kernel Function	Triangular	Triangular	Triangular	Triangular

Panel E. Forced turnover

	Forced Turnover$_{t+1}$			
	(1)	(2)	(3)	(4)
Estimation				
Estimated Kink	-0.418	-0.115	-0.055	0.065
Std. Error	0.459	0.236	0.151	0.053
P-value	0.363	0.626	0.718	0.22
Left of Cutoff (BTM = 1)				
Bandwidth	0.1	0.15	0.2	0.426
Eff. Number of Obs.	979	1,602	2,299	7,251
Right of Cutoff (BTM = 1)				
Bandwidth	0.1	0.15	0.2	0.426
Eff. Number of Obs.	658	933	1,153	1,853
Kernel Function	Triangular	Triangular	Triangular	Triangular

Panel F. R&D expenditures

	$R\&D_{t+1}$			
	(1)	(2)	(3)	(4)
Estimation				
Estimated Kink	-0.047	-0.046	0.017	0.011
Std. Error	0.244	0.129	0.083	0.022
P-value	0.847	0.723	0.833	0.632
Left of Cutoff (BTM = 1)				
Bandwidth	0.1	0.15	0.2	0.51
Eff. Number of Obs.	1,472	2,382	3,336	12,756
Right of Cutoff (BTM = 1)				
Bandwidth	0.1	0.15	0.2	0.51
Eff. Number of Obs.	1,038	1,478	1,917	3,551
Kernel Function	Triangular	Triangular	Triangular	Triangular

Panel G. Over-investments in capital expenditures and acquisitions

	$Over\text{-}investment_{t+1}$			
	(1)	(2)	(3)	(4)
Estimation				
Estimated Kink	0.46	0.162	0.076	0.015
Std. Error	0.465	0.247	0.163	0.049
P-value	0.323	0.513	0.641	0.761
Left of Cutoff (BTM = 1)				
Bandwidth	0.1	0.15	0.2	0.471
Eff. Number of Obs.	2,917	4,653	6,451	20,115
Right of Cutoff (BTM = 1)				
Bandwidth	0.1	0.15	0.2	0.471
Eff. Number of Obs.	2,212	3,170	4,012	7,124
Kernel Function	Triangular	Triangular	Triangular	Triangular

Table 9. Impairment vs. Non-Impairment in the prior period

This table presents results showing how the kink effects vary with the recognition of asset impairments in the prior period. We examine the monitoring and investment variables for firms that report asset impairments in period *t* and compare them with firms that do not report asset impairments in period *t*. In columns 1-3, we use bandwidth of 0.1, 0.15, and 0.2, respectively. In column 4, the bandwidth and the estimated kink effects are optimally calculated following Calonico et al. (2014) and Calonico et al. (2017) using the nonparametric local 1-order polynomial model (i.e., polynomial order = 1). P-values are in parentheses. Standard errors are adjusted for heteroscedasticity and three nearest neighbor observations. Appendix A provides detailed variable descriptions.

Panel A. Sample firms with asset impairments in the prior period

	(1)	(2)	(3)	(4)
Objected Proposals$_{t+1}$				
- Estimated kink	0.169	-0.289	0.054	0.242
- P-value	(0.908)	(0.732)	(0.927)	(0.605)
- Bandwidth	0.1	0.15	0.2	0.244
- Obs. in left cutoff	1,464	2,162	2,883	3,493
- Obs. in right cutoff	1,164	1,476	1,699	1,844
Voting % of Objected Proposals$_{t+1}$				
- Estimated kink	-0.012	-0.023	-0.005	0.012
- P-value	(0.958)	(0.858)	(0.951)	(0.863)
- Bandwidth	0.1	0.15	0.2	0.237
- Obs. in left cutoff	1,464	2,162	2,883	3,403
- Obs. in right cutoff	1,164	1,476	1,699	1,824
Forced Turnover$_{t+1}$				
- Estimated kink	0.338	0.380	0.261	0.130
- P-value	(0.481)	(0.169)	(0.173)	(0.284)
- Bandwidth	0.1	0.15	0.2	0.286
- Obs. in left cutoff	780	1,210	1,651	2,390
- Obs. in right cutoff	536	675	772	894
R&D$_{t+1}$				
- Estimated kink	-0.651	-0.249	-0.062	0.068
- P-value	(0.130)	(0.264)	(0.677)	(0.174)
- Bandwidth	0.1	0.15	0.2	0.492
- Obs. in left cutoff	871	1,362	1,870	4,859
- Obs. in right cutoff	580	819	992	1,518
Over-investment$_{t+1}$				
- Estimated kink	-0.174	-0.220	-0.099	0.111**
- P-value	(0.768)	(0.504)	(0.653)	(0.031)
- Bandwidth	0.1	0.15	0.2	0.706
- Obs. in left cutoff	1,615	2,322	3,022	8,308
- Obs. in right cutoff	1,241	1,573	1,831	2,729

Panel B. Sample firms with no asset impairments in the prior period

	(1)	(2)	(3)	(4)
Objected Proposals$_{t+1}$				
- Estimated kink	0.837*	0.811**	0.781***	0.794***
- P-value	(0.090)	(0.012)	(0.001)	(0.003)
- Bandwidth	0.1	0.15	0.2	0.175
- Obs. in left cutoff	8,138	10,922	13,364	12,192
- Obs. in right cutoff	5,046	5,729	6,241	5,994
Voting % of Objected Proposals$_{t+1}$				
- Estimated kink	0.235***	0.181***	0.162***	0.179***
- P-value	(0.004)	(0.000)	(0.000)	(0.000)
- Bandwidth	0.1	0.15	0.2	0.153
- Obs. in left cutoff	8,138	10,922	13,364	11,028
- Obs. in right cutoff	5,046	5,729	6,241	5,760
Forced Turnover$_{t+1}$				
- Estimated kink	0.092	0.111	0.143	0.142
- P-value	(0.750)	(0.538)	(0.275)	(0.224)
- Bandwidth	0.1	0.15	0.2	0.225
- Obs. in left cutoff	2,825	4,096	5,303	5,869
- Obs. in right cutoff	1,210	1,409	1,548	1,587
R&D$_{t+1}$				
- Estimated kink	0.527***	0.378***	0.304***	0.308***
- P-value	(0.006)	(0.000)	(0.000)	(0.000)
- Bandwidth	0.1	0.15	0.20	0.196
- Obs. in left cutoff	2,389	3,798	5,340	5,208
- Obs. in right cutoff	1,553	2,038	2,469	2,439
Over-investment$_{t+1}$				
- Estimated kink	-0.787***	-0.599***	-0.485***	-0.590***
- P-value	(0.008)	(0.001)	(0.000)	(0.001)
- Bandwidth	0.1	0.15	0.2	0.156
- Obs. in left cutoff	9,161	12,022	14,512	12,311
- Obs. in right cutoff	5,475	6,249	6,866	6,331

Table 10. BTM of Assets and Discretionary Accruals

This table examines whether firms with the BTM ratio of assets below 1 engage in more earnings management compared to firms with the BTM ratio of assets above 1. We examine whether discretionary accruals in period *t-1*, *t*, and *t+1* exhibit kinks at the BTM ratio equal to 1 in period *t*. In columns 1-3, the bandwidth of 0.1, 0.15, and 0.2 is used, respectively. In column 4, the bandwidth and the estimated kink effects are optimally calculated following Calonico et al. (2014) and Calonico et al. (2017) using the nonparametric local 1-order polynomial model (i.e., polynomial order = 1). Standard errors are adjusted for heteroscedasticity and three nearest neighbor observations. Appendix A provides detailed variable descriptions.

	(1)	(2)	(3)	(4)
Disc Accruals$_{t+1}$				
- Bandwidth	0.1	0.15	0.2	0.336
- Estimated Kink	-0.050	-0.039	-0.019	-0.024
- P-value	(0.762)	(0.675)	(0.756)	(0.460)
- Obs. in left	6877	10450	14260	24710
- Obs. in right	5007	6486	7691	9776
Disc Accruals$_{t}$				
- Bandwidth	0.1	0.15	0.2	0.349
- Estimated Kink	-0.030	-0.079	-0.044	0.017
- P-value	(0.856)	(0.399)	(0.490)	(0.590)
- Obs. in left	7234	11016	15022	27307
- Obs. in right	5305	6899	8208	10637
Disc Accruals$_{t-1}$				
- Bandwidth	0.1	0.15	0.2	0.759
- Estimated Kink	-0.009	-0.050	-0.045	-0.005
- P-value	(0.958)	(0.599)	(0.480)	(0.742)
- Obs. in left	7098	10797	14726	54538
- Obs. in right	5121	6680	7985	12818

Table 11. Kink effects on missing R&D

This table examines whether disclosure of missing R&D in period *t+1* exhibit a kink at the BTM ratio equal to 1 in period *t*. We compare the slope estimated from samples lying on the right-hand side of the kink point and the slope estimated from those lying on the left-hand side of the kink point. The outcome variable is *Missing* $R\&D_{t+1}$ (Koh and Reeb 2015), and the assignment variable is the BTM ratio in period *t* (BTM_t). The bandwidth and the estimated kink effects are optimally calculated following Calonico et al. (2014) and Calonico et al. (2017) using the nonparametric local 1-order polynomial model (i.e., polynomial order = 1). Standard errors are adjusted for heteroscedasticity and three nearest neighbor observations. Appendix A provides detailed variable descriptions.

	Missing $R\&D_{t+1}$
Estimation	
Estimated Kink	0.401***
Std. Error	0.094
P-value	0.000
Left of Cutoff (BTM = 1)	
Bandwidth	0.124
Eff. Number of Obs.	17,731
Right of Cutoff (BTM = 1)	
Bandwidth	0.124
Eff. Number of Obs.	11,332
Kernel Function	Triangular

Table 12. Implications for long-run productivity: Future patenting activities

This table examines whether patents filed between period *t+1* and period *t+3* exhibit kink at the BTM ratio equal to 1 in period *t*. In column (1), the outcome variable is the natural log of the average number of patents filed between period *t+1* and period *t+3* ($Patents_{t+1,\, t+3}$). In column (2), the outcome variable is the quality of the patent, which is defined as the natural log of the average patent value (Kogan et al. 2017) between period *t+1* and period *t+3* ($Patent\ Value_{t+1,\, t+3}$). We compare the slope estimated from samples lying on the right-hand side of the kink point and the slope estimated from those lying on the left-hand side of the kink point. The assignment variable is the BTM ratio in period *t* (BTM_t). The bandwidth and the estimated kink effects are optimally calculated following Calonico et al. (2014) and Calonico et al. (2017) using the nonparametric local 1-order polynomial model (i.e., polynomial order = 1). Standard errors are adjusted for heteroscedasticity and three nearest neighbor observations. Appendix A provides detailed variable descriptions.

	$Patents_{t+1,\, t+3}$	$Patent\ Value_{t+1,\, t+3}$
	(1)	(2)
Estimation		
Estimated Kink	2.586***	1.18***
Std. Error	0.258	0.205
P-value	0.000	0.000
Left of Cutoff (BTM = 1)		
Bandwidth	0.175	0.174
Eff. Number of Obs.	17,409	17,335
Right of Cutoff (BTM = 1)		
Bandwidth	0.175	0.174
Eff. Number of Obs.	8,733	8,708
Kernel Function	Triangular	Triangular

Appendix A. Variable definitions

- BTM_t is the book-to-market ratio at the end of period *t* and defined as the book value of total assets divided by the market value of assets at the end of period *t*. The market value of assets is measured as the market value of equity plus the book value of total liabilities measured as the book value of total assets less the book value of equity.
- $Impairment\ Indicator_{t+1}$ is an indicator equals to 1 if the sum of goodwill impairments and the long-lived assets write-downs in period *t+1* is positive, 0 otherwise.
- $Impairments_{t+1}$ is the asset impairment losses in period *t+1* and measured as the sum of the goodwill impairments and the long-lived asset write-downs in period *t+1*, scaled by the market value of equity at the end of period *t*.
- $Objected\ Proposals_{t+1}$ is the number of management-initiated proposals for which ISS recommends withhold, against, or no vote and receives more than twenty percent of dissident shareholder votes, i.e., "Voted against" and "Voted abstain."
- $Voting\ \%\ of\ Objected\ Proposals_{+1}$ is the percentage of shareholder votes in the $Objected\ Proposals_{t+1}$ variable.
- $Forced\ Turnover_{t+1}$ is the indicator variable equal to 1 if there is a forced CEO turnover in period *t+1*, zero otherwise. Forced CEO turnover data is hand-collected following algorithm in Parrino (1997).
- $R\&D_{t+1}$ is the R&D expenditures of the firm in period *t+1*, scaled by the market value of equity at the end of period *t*.
- $Patents_{t+1,t+3}$ is the natural log of 1 plus the average number of patents filed between period *t+1* and *t+3* (Kogan et al. 2017).
- $Over\text{-}investment_{t+1}$ is an indicator of over-investment in capital expenditures and acquisitions. We estimate the regression of investments in period *t*+1 on sales growth in period *t* (i.e., $Investment_{t+1} = \beta_0 + \beta_1 Sales\ Growth_t + \varepsilon$). $Investment_{t+1}$ is the sum of capital expenditures and acquisitions less cash receipts from sale of property, plant, and equipment in period *t*+1 multiplied by 100 in period *t*+1 and scaled by lagged total assets. $Sales\ Growth_t$ is defined as the percentage change in sales from period *t*-1 to period *t* and multiplied by 100. We estimate this regression model for each industry-year based on the three-digit SIC industry classification. We require at least 20 observations for each estimation. We then sort firms based on the magnitude of the residuals into quantiles. $Over\text{-}investment_{t+1}$ is equal to 1 for the firm-year observations that belong to the top quantile, zero otherwise.
- $Patent\ Value_{t+1,t+3}$ is the natural log of 1 plus the average of the estimated value of patents filed between period *t+1* and *t+3*. (Kogan et al. 2017).
- $Disc\ Accruals_t$ is performance-matched discretionary accruals in period *t*, defined following Kothari et al. 2005. $Disc\ Accruals_t$ is computed as a firm's discretionary accruals minus the discretionary accruals of a matched firm in the same three-digit SIC industry classification with the closest return on assets (ROA) in the prior period. Following Kothari et al. (2005), a firm's discretionary accruals are based on Dechow et al. (1995).
- $Missing\ R\&D_{t+1}$ is an indicator equal to 1 if a firm's R&D is missing in Compustat in period *t+1* while the firm reports at least one patent filing during the past ten years (Koh and Reeb 2015).

Appendix B. Estimation model

We build on a nonparametric local polynomial identification framework documented by Calonico et al. (2014) and Card et al. (2015), which allows non-separability of the error term. Card et al. (2015) study a general single kink model,

$$Y = y(P, X, \varepsilon)$$

where *Y* is an outcome, *P* is a policy-related variable of interest, *X* is another observed covariate (assignment variable), and ε is a potentially multidimensional error term that enters the function *y* in a non-additive way. We assume that *P* = *p*(*X*). The outcome variable *Y* is monitoring- and investment-related variables. *P* is goodwill/long-lived asset impairment loss recognition. *X* is the BTM ratio. The treatment effect estimated using Kink Design can be described as,

$$T_{rk} = \frac{dE[Y_{1i} - Y_{0i}|X_i = x] / dx}{dE[P|X_i = x] / dx} = \frac{dE[Y_{1i}|X_i = x] / dx}{dE[P|X_i = x] / dx} - \frac{dE[Y_{0i}|X_i = x] / dx}{dE[P|X_i = x] / dx} \quad \text{(A1)}$$

where i stands for units, Y_{1i} is the outcome when i is in the treated group, Y_{0i} is the outcome when i is in the control group, and x is the kink point. Under the small window of h left of x and the small window of h right of x, i.e., $x - h < X_i < x, x < X_i < x + h$, equation (A1) can be re-written as the following:

$$T_{rk} = \lim_{h \to 0} \frac{dE[Y_{1i}|x < X_i < x + h] / dx}{dE[P|x < X_i < x + h] / dx} - \lim_{h \to 0} \frac{dE[Y_{0i}|x - h < X_i < x] / dx}{dE[P|x - h < X_i < x] / dx} \quad \text{(A2)}$$

where x will be 1 in our setting (BTM equal to 1 is the kink point). Using a local polynomial estimation approach, we recover T_{rk} by estimating $\hat{T}_{rk}$ in the following way:

$$\hat{T}_{rk} = (\hat{\beta}_1^+ - \hat{\beta}_1^-) / (\hat{R}_1^+ - \hat{R}_1^-) \quad \text{(A3)}$$

where,

$$\widehat{\beta_1} = \underset{\{\beta_1\}}{\operatorname{argmin}} \sum_{i=1}^{N} \left\{Y_i - \sum_{j=0}^{p} \beta_j (X_i - x)^j\right\}^2 K\left(\frac{X_i - x}{h}\right) \quad \text{(A4)}$$

$$\widehat{R_1} = \underset{\{R_1\}}{\operatorname{argmin}} \sum_{i=1}^{N} \left\{P_i - \sum_{j=0}^{p} R_j (X_i - x)^j\right\}^2 K\left(\frac{X_i - x}{h}\right) \quad \text{(A5)}$$

In this equation, *N* stands for the number of observations in the bandwidth *h*, *K* is the kernel function that defines the weight given to the observations in bandwidth *h*, and *p* is the polynomial order of underlying conditional mean function of outcome Y_i within the bandwidth. $\hat{\beta}_1^+$ is the estimated coefficient of first-order derivative (i.e., slope) of the underlying functional form that minimizes estimation error (i.e., Y_i- $\hat{Y}_i$) using the observations in the right window of cutoff $x = 1$. $\hat{\beta}_1^-$ is estimated using the observations in the left window of cutoff $x = 1$. Therefore, $(\hat{\beta}_1^+ - \hat{\beta}_1^-)$ is the difference of a slope estimated from the right side of window BTM equal to 1 and a slope estimated from the left side of window BTM equal to 1 in the relation between outcome *Y* (e.g., monitoring, R&D, over-investments) and the BTM ratio. $(\hat{R}_1^+ - \hat{R}_1^-)$ is the difference between a slope estimated from the right side of window BTM equal to 1 and a slope estimated from the left side of window BTM equal to 1 in the relation between policy variable P (i.e., impairment loss recognition) and the BTM ratio.

Following Card et al. (2015), we estimate a nonparametric local 1-order polynomial model (p = 1) and a local 2-order polynomial model (p = 2). We use a triangular kernel function which denotes higher weights to the observations that are closer to the kink point.[31] For bandwidth choice h, we estimate MSE (mean squared error) optimal bandwidth following Calonico et al. (2014) and Card et al. (2015).

Defining bandwidth (h) is very important in estimating the precise treatment effect (Lee and Lemieux 2010). All the bandwidth choices available in the literature are obtained by balancing squared-bias and variance of the RKD estimator.[32]

Lee and Lemieux (2010) address practical issues in selecting bandwidth in terms of the trade-off between bias and precision of the estimated treatment effect.[33] On the one hand, in finite samples, the bandwidth has to be large enough to include enough observations to get a reasonable amount of precision in the estimation of predicted values of Y. Thus, using a larger bandwidth provides more precise estimates as more observations are available to estimate the underlying model. On the other hand, the increase in bandwidth comes at the cost of bias in the estimated treatment effect. In other words, when bandwidth is relatively large, the estimated kink effect will have less variability (higher precision), but the estimated kink effect might be different from the actual kink effect (i.e., biased estimation). In short, the bias and precision can be described as the following: the attempts to reduce the bias by shrinking the bandwidth will result in an extremely noisy estimation of the treatment effect, while the attempts to reduce the nosiness of estimation by increasing the bandwidth will result in biased estimation of the treatment effect. All bandwidths chosen to estimate kink effects in this paper are selected optimally to minimize the MSE of the estimated kink effect $\hat{T}_{rk}$ instead of being chosen ad hoc. In order to conservatively estimate kink effects, we estimate the kink effects using a triangular kernel function, which gives higher weight to the observations that are closer to the kink points.

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[31] The triangular kernel is $K(u/h) = (1 - |u|) \times 1_{|u| \leq 1}$ widely used in recent RKD or RD (regression discontinuity) applications. The choice of kernel function turns out to be less important than the choice of bandwidth h (Kisin and Manela 2018).

[32] The treatment effect estimator $\hat{T}(h)$ follows MSE (mean-squared error) expansion. Let $X_n = (X_1, X_2, \ldots . X_n)'$. $MSE\ (h_n) = E\left[\ \left\{\hat{T}(h_n)\ - T\right\}^2 |X_n\right] \approx h_n^{2(p+1)} B_n{}^2 + \frac{1}{nh_n} V_b$, with $B_n \to B$ and $V_n \to V$ where B and V represent, respectively, the asymptotic bias and the asymptotic variance of $\hat{T}\ (h_n)$. p is the polynomial order and n is the number of observations within bandwidth h. This treatment effect estimator will be consistent if $h_n \to 0$ and $nh_n \to \infty$. Moreover, the point estimator $\hat{T}\ (h_n)$ will be optimal in an asymptotic MSE sense if the bandwidth h_n is chosen so that $h_{mse,\,n} = \left[\frac{V/n}{2(1+p)B^2}\right]^{\frac{1}{3+2p}}$. The bandwidth in tables is calculated by this function (Calonico et al. 2017).

[33] Bandwidth (h) enters into the function as a multiplication term with the bias term (B) while bandwidth (h) enters into the function as inverse-multiplication term with the variance term (V). Therefore, as optimal bandwidth increases, bias has more impact on determining MSE (mean-squared error) while as bandwidth decreases, variance has more impact on determining MSE. Therefore, the "relatively large" bandwidth will be optimal in a sense of minimizing MSE, but the estimated treatment effect using the "relatively large" bandwidth might be biased.

Appendix C. Robustness tests controlling for publicly observable signals

This table examines the robustness of kink effects controlling for past stock returns in period *t* and period *t-1* as a covariate in RKD estimation. We use the nonparametric local 1-order polynomial model (Polynomial order equal to 1, kink point equal to 1). P-values are in parentheses. Standard errors are adjusted for heteroscedasticity and three nearest neighbor observations. Appendix A provides detailed variable descriptions. Appendix A provides detailed variable descriptions.

	Impairment Indicator	*Impairments*	*Objected Proposals*	*Voting % of Objected Proposals*	*Forced Turnover*	*R&D*	*Over-investment*
Estimation							
Estimated Kink	1.171***	0.132***	0.639***	0.132***	0.103	0.247***	-0.423***
Std. Error	0.267	0.036	0.167	0.046	0.084	0.086	0.111
P-value	0.000	0.000	0.000	0.004	0.222	0.004	0.000
Left of Cutoff (BTM = 1)							
Bandwidth	0.099	0.105	0.283	0.172	0.247	0.174	0.220
Eff. Number of Obs.	11,074	11,598	19,695	13,240	8,314	4,887	15,449
Right of Cutoff (BTM = 1)							
Bandwidth	0.099	0.105	0.283	0.172	0.247	0.174	0.220
Eff. Number of Obs.	6,791	6,967	7,589	6,488	2,387	2,390	6,873
Kernel Function	Triangular	Triangular	Triangular	Triangular	Triangular	Triangular	Triangular

Appendix D. Robustness tests based on different polynomial estimation order

This table examines the robustness of kink effects using the nonparametric local 2-order polynomial model, i.e., polynomial order = 2. We compare the slope estimated from samples lying on the right-hand side of the kink point and the slope estimated from those lying on the left-hand side of the kink point. The bandwidth and the estimated kink effects are optimally calculated following Calonico et al. (2014) and Calonico et al. (2017) using the local 2-order polynomial order model (i.e., polynomial order = 2). Standard errors are adjusted for heteroscedasticity and three nearest neighbor observations. Appendix A provides detailed variable descriptions.

	Impairment Indicator	*Impairments*	*Objected Proposals*	*Voting % of Objected Proposals*	*Forced Turnover*	*R&D*	*Over-investment*
Estimation							
Estimated Kink	1.474***	0.269***	1.534***	0.283***	0.258*	0.234***	-0.951***
Std. Error	0.117	0.038	0.386	0.071	0.149	0.08	0.236
P-value	0.000	0.000	0.000	0.000	0.083	0.003	0.000
Left of Cutoff (BTM = 1)							
Bandwidth	0.439	0.336	0.338	0.297	0.423	0.471	0.293
Eff. Number of Obs.	49,576	39,592	24,775	22,218	14,453	20,078	23,236
Right of Cutoff (BTM = 1)							
Bandwidth	0.439	0.336	0.338	0.297	0.423	0.471	0.293
Eff. Number of Obs.	18,410	17,060	9,158	8,869	2,773	5,010	9,839
Kernel Function	Triangular	Triangular	Triangular	Triangular	Triangular	Triangular	Triangular

Appendix E. Estimation of sensitivity changes at BTM ratio equal to 1 using OLS

This table compares the sensitivity differences at BTM ratio (BTM_t) equal to 1 in pre- and post-SFAS 121 periods using pooled OLS regression. $BTMD_t$ is an indicator equal to 1 if BTM_t is greater than 1, zero otherwise. $Post_t$ is an indicator equal to 1 in the post-SFAS 121 period, zero otherwise. We regress R&D expenditures ($R\&D_{t+1}$) and the indicator of over-investment in capital expenditures and acquisitions in period *t+1* ($Over\text{-}investment_{t+1}$) on the interaction of BTM_t, $BTMD_t$, and $Post_t$. Other variables are described in Appendix A. Standard errors are clustered at the firm level.

	$R\&D_{t+1}$		$Over\text{-}investment_{t+1}$	
	(1)	(2)	(3)	(4)
BTM_t	0.042***	0.105***	-0.191***	-0.228***
	(9.691)	(24.732)	(-13.490)	(-16.423)
$BTMD_t$	-0.000	0.053***	-0.180***	-0.234***
	(-0.009)	(2.956)	(-7.026)	(-9.413)
$BTMt \times BTMD_t$	**0.011**	**-0.051*** **	**0.156*** **	**0.210*** **
	(0.572)	**(-3.184)**	**(6.590)**	**(9.168)**
$Post_t$	0.021***	0.037**	-0.054***	0.037
	(7.555)	(2.193)	(-4.849)	(0.913)
$BTM_t \times Post_t$	-0.029***	-0.019***	0.062***	0.045***
	(-5.950)	(-4.211)	(4.137)	(3.046)
$BTMD_t \times Post_t$	-0.127***	-0.072***	0.107***	0.065**
	(-4.856)	(-3.413)	(3.661)	(2.250)
$BTM_t \times BTMD_t \times Post_t$	**0.114*** **	**0.063*** **	**-0.101*** **	**-0.066** **
	(5.000)	**(3.383)**	**(-3.839)**	**(-2.540)**
Year Fixed Effects	No	Yes	No	Yes
Industry Fixed Effects	No	Yes	No	Yes
Number of Observations	96,259	96,259	131,048	131,048
Adjusted R^2	0.026	0.253	0.016	0.042